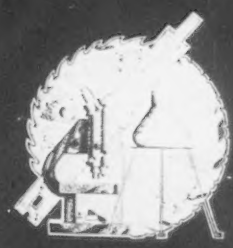
FOREST PRODUCTS JOURNAL



FOREST PRODUCTS RESEARCH SOCIETY

Wood Particles + Resin = Profitable Molded Products, p. 179

1960/APRIL

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THE FOREST PRODUCTS JOURNAL is published monthly by the Forest Products Research Society, 417 North Walnut Street, Madison 5, Wisconsin. Second-class postage paid at Madison, Wisconsin.

Annual subscription rate, $15.00; single copies $1.00, except October Yearbook Number, $4.00. Annual subscription rate is $11.25 with voting, associate, and supporting memberships in the Society. Remittances should be made payable to the Forest Products Research Society.

Correspondence on editorial matters should be addressed to the Editor, at the Executive Office. The Society is not responsible for views expressed in publications.

Plan Now to Attend FPRS' 14th National Meeting in Montreal June 5 thru 9!

-:-

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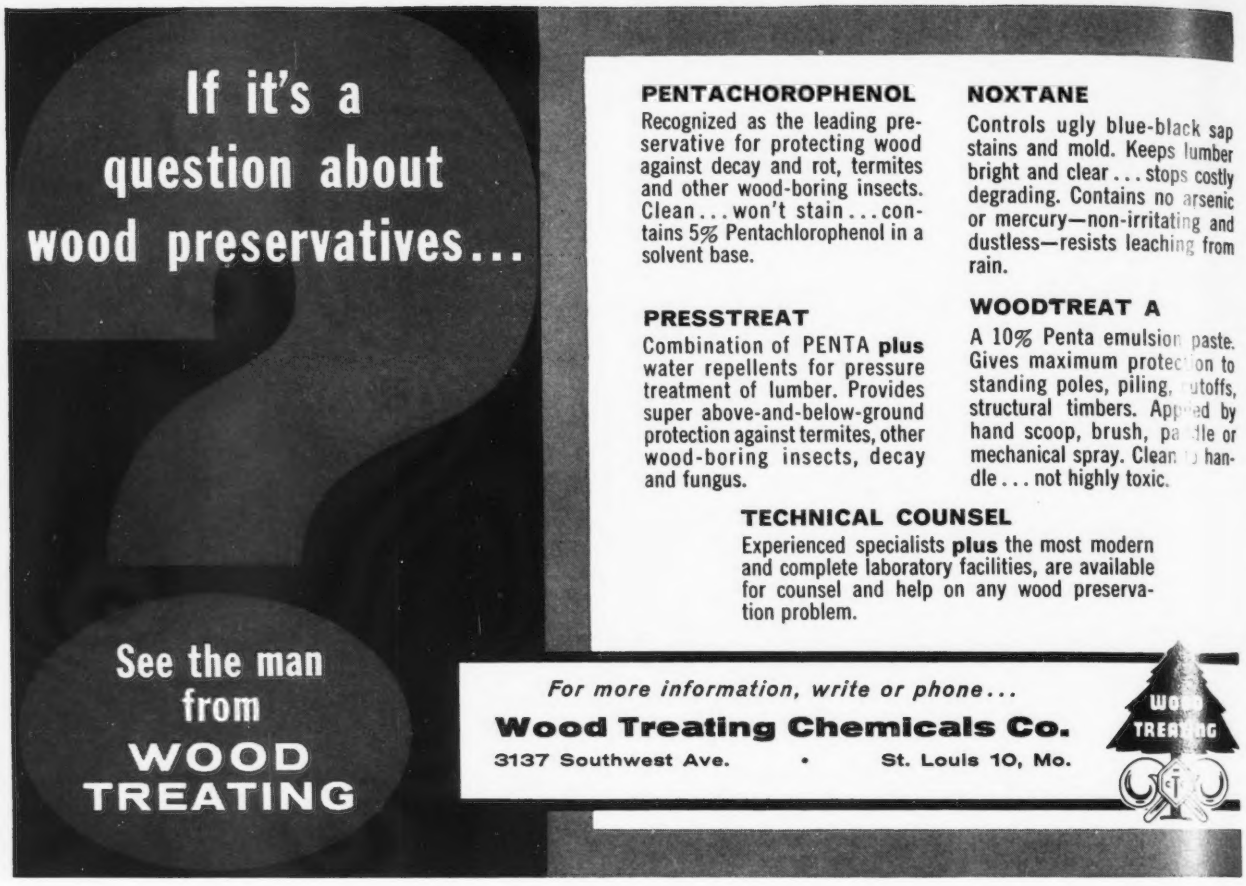
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FOURTEENTH ANNUAL MEETING—FOREST PRODUCTS RESEARCH SOCIETY
Montreal, Canada—June 5–9, 1960

Please mail to: FOREST PRODUCTS RESEARCH SOCIETY, P.O. Box 38, STATION B, Montreal, Quebec
(All Registrations should reach this office not later than May 27, 1960)

(PLEASE PRINT OR TYPE)

Name _____
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Address _____

City, Zone, State _____

Company or Organization _____

FPRS MEMBER—Advance Registration Fee $30.00 (Fee at Meeting $40)
NON-MEMBER—Advance Registration Fee $40.00 (Fee at Meeting $50)

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Note:
Registration fee covers complete program, including men and ladies' registration fees, host section reception, official luncheon, Paul Bunyan party, annual banquet, ladies' breakfasts, ladies' luncheon and fashion show, city tour and plant tours.
Be sure to indicate whether delegate is to be accompanied by wife.

Accompanied by Wife? _____
(First Name)

Children—Name _____ Age _____
—Name _____ Age _____

MAKE CHECKS PAYABLE TO FPRS 1960 NATIONAL MEETING COMMITTEE

The Queen Elizabeth is the headquarters hotel, and a block of rooms has been reserved for those attending the meeting. However, it is important that you make your reservation early. Reservations must be received by May 21st, after which the hotel may use the rooms for other guests. On the line below, please indicate where you plan to stay in Montreal, whether at a hotel, a motor or with friends.

Fees subject to refund if cancellation is received by May 27, 1960

THE PRESIDENT'S COLUMN

R. BERRY
Acting President

At the meeting of the Executive Board of the Society, held in Chicago on January 19th and 20th of this year, prolonged consideration was given to the Society's audit and 1960 budget. The figures showed that our costs for services and publication were growing faster than our income. Although membership and the resulting dues had somewhat increased over the year previous, there has been a falling off in returns from advertising in the *Journal* with the result that the board members felt that either drastic cuts had to be made in services rendered to the members and in the publication of the *Journal* or added income had to be provided through the raising of dues.

After full discussion, the Board passed a resolution authorizing the submission of an amendment to the constitution to effect the raising of the dues of voting and associate members from $15.00 to $20.00 per year. The dues for supporting and student members would remain the same. In order that the change may be clearly set before the membership, the motion passed by the Board is as follows:

"That article 5, Section 3 of the constitution be amended to read:

'Dues for voting and associate members shall be $20.00 per year, $2.50 of which will be returned to Sections to help defray administrative expenses. Dues for a one-year period will be due and payable on or before the first day of the month in which a member is accepted for membership. Thereafter his yearly dues will be due and payable on or before the 1st of the month of joining. Members shall be entitled to all publications for a twelve-month period from the date of joining.'"

The Executive Secretary was instructed to send notice of the proposed Constitutional changes to the members in advance of the forthcoming annual meeting.

In passing the foregoing resolution and proposal for constitutional amendment, the Board followed the suggestions made by many members, by the Publications Committee, and by the Budget and Finance Committee. It seemed obvious in the discussion that the Society had reached a critical period in its development and that the increase in dues was but part of the general program which includes the formulation of the Society's future policy through the newly established Policy Committee together with the general integration of the Society through the bringing together of the work of the Sections and the Divisions. All of this also had much to do with our future policy regarding the publication of the *Journal*. In short, the purpose of the increase in dues is to improve the publication of the *Journal* and the services of the Society for all the membership.

It is hoped, therefore, that the new proposed constitutional amendments both in regard to dues and the establishment of Divisions will receive full approval at the forthcoming meeting.

FPRS News-Digest

The Queen Elizabeth, FPRS Headquarters in Montreal

Honorable Lionel Chevrier Guest Speaker At FPRS Montreal Meeting June 5-9

Montreal.—Guest speaker at the 14th National Meeting of the Forest Products Research Society to be held here June 5–9 will be the Honorable Lionel Chevrier, Member of Parliment (Liberal) for Montreal–Laurier.

Hon. Lionel Chevrier

The subject of Mr. Chevrier's talk at the FPRS Luncheon Meeting on June 7th will be "The St. Lawrence Seaway—Its Impact Upon the Economy after the First Season of Operation."

Mr. Chevrier was Minister of Transport under Prime Minister Louis St. Laurent. In July 1954, he resigned as Minister of Transport and was appointed President of the St. Lawrence Seaway Authority. In 1957, he was appointed President of the Privy Council in the Liberal Cabinet.

Mr. Chevrier has a wide experience in law, industry, and government. He is a sought-after speaker noted for his outstanding delivery.

TECHNICAL PROGRAM

SESSION 1

GENERAL

Monday, June 6, 8:45-12:30 p.m.

"FPRS Honorarium Lecture," sponsored by the FPRS Midwest Section. Dr. A. J. Stamm, Visiting Lecturer, School of Forestry, North Carolina State College, Raleigh, N. C.

Stamm

Bescher

SESSION 2

WOOD PRESERVATION

Monday, June 6, 2:00-4:30 p.m.

Program Chairman, R. H. Bescher, Assistant to Vice-President, Koppers Company, Inc., Pittsburgh 19, Pa.

"Methods of Specifying and Inspecting Marine Piles Used by the Lake Charles Port Authority," Monie Hudson, Spartanburg, South Carolina.
"Weathering of Creosote During Exposure in ¾-inch Pine Stakes," S. W. Leach, Trafford, Pa.
"Creosote-Pentachlorophenol Solution—A Fortified Wood Preservative For Southern Pine Poles," G. O. Lumsden, Timber Products Eng., Bell Tel. Labs., Inc. Murray Hill, N.J.
"Wood Preservative Test Data as a Guide in Establishing Customer Specifications," H. A. Huber, Dow Chemical Co., Midland, Mich.

The fifth speaker will be R. F. De Grace, Canadian Inst. of Timber Construction, Ottawa, Ont., Can.

Kurtenacker

Kner

Newman

SESSION 3

PACKAGING

Monday, June 6, 2:00-4:30 p.m.
Program Chairman, Karl Bollerslev, Boise Cascade Corp., Box 290, Boise, Idaho.
"Wood's Future in the Packaging Industry," R. S. Kurtenacker, Engineer USFPL, Madison.
"Problems Relative to Use of Container Board and Wood from Consumer Viewpoint," W. L. Newman, Mgr., Packaging Division, Services and Packaging Lab., General Electric Co., Schenectady, N. Y.
"Packaging Design — Using Wood and Wood Products," Albert Kner, Design Engineer, Container Corp. of America.

SESSION 4

CHEMICAL UTILIZATION

Monday, June 6, 2:00-4:30 p.m.
Program Chairman, F. G. Perry, Jr., A. D. Little Co., 30 Memorial Drive (Acorn Park), Cambridge, Mass., and Mrs. Claire Canty, A. D. Little Co., 30 Memorial Drive (Acorn Park), Cambridge, Mass.
"Wood Carbonization in Small Kilns," Paul Lane, Lake States Forest Exp. Sta., Wausau, Wis.
"Pulping of Sawdust," Mr. Kuhlman, Potlatch Forests, Inc., Lewiston, Idaho.
"Wood Flour plus Polyurethane System." A. D. Little Co., and Wilner Wood Products Company.

Mottet

Marra

Hamilton

SESSION 5

WOOD COMPOSITION BOARD

Monday, June 6, 2:00-4:30 p.m.
Debate on End-Use Approach vs. Properties-Class Approach to Particle Board Standards, Presiding Chairman: A. L. Mottet, Recorder, R. W. Young, Long-Bell Div. International Paper Co., Longview, Wash.
Recorder, R. W. Young, Long-Bell Div. International Paper Co., Longview, Wash.
"Advantages of the End-Use Approach to Particle Board Standards," James Hamilton, Mich. College of Mining & Technology, Houghton, Mich.; and Dr. George Marra, Washington State Institute of Technology, Pullman, Wash.
"Advantages of the Properties Classification Approach to Particle Board Standards," Wayne Lewis, USFPL, Madison, Wis.; and Sigurd Johnson, N. C. State College.

SESSION 6

WOOD MACHINING

Tuesday, June 7, 8:45-11:30 a.m.
Program Chairman, N. C. Franz, Univ. of Michigan, Ann Arbor. Presiding Chairman, C. P. Berolzheimer, Calif. Cedar Products Co., Stockton, Calif.
"Machinery Research," William McKenzie, Univ. of Michigan, (on leave from FPL, Melbourne, Australia)
"Stress Analysis in Circular Headsaws," G. W. Andrews and J. S. Johnston, FPLC, Ottawa.
Russian Motion Picture, "Woodcutting," Richard Perkins, N. Y. State College of Forestry, Syracuse, N. Y.
"Appraisal of Foreign Activities in Wood Machining," Les Reineke, USFPL, Madison, Wis.

Nowacki

Hager

Brand

SESSION 7

WOOD FINISHING

Tuesday, June 7, 8:45-11:30 a.m.
Program Chairman, N. C. Hatcher, Jr., Drexel Furniture Co., Drexel, N. C.
"Research on Wood Finishes," B. G. Brand, L. J. Nowacki, H. N. Johnston, Battelle Memorial Institute, Columbus, Ohio.
"Wood Finishes—How Good Are They?" J. A. Hager, Grand Rapids Varnish Corp., Grand Rapids, Mich.
"Production Finishing Problems," G. M. Hill, Drexel Furniture Company, Drexel, N. C.

SESSION 8

CHEMICAL UTILIZATION

Tuesday, June 7, 8:45-11:30 a.m.
Program Chairman, F. G. Perry, Jr., A. D. Little Co., 30 Memorial Drive (Acorn Park), Cambridge, Mass., and Mrs. Claire Canty, A. D. Little Co., 30 Memorial Drive (Acorn Park), Cambridge, Mass.
"Use of Bark Extractives in Cold Set Adhesives," Dr. Herrick, Rayonier Inc.
"Commercial Applications of Lignosulfinate," Ross L. Robinson, Lignosols Chemicals, Ltd. Quebec, Can.

Freeman

Northcott

Wangaard

SESSION 9

GLUES & GLUING

Tuesday, June 7, 2:30-5:00 p.m.
Program Chairman, B. S. Bryant, Assoc. Prof., College of Forestry, Univ. of Washington, Seattle.
"Estimating Bond Quality in Plywood," Philip Northcott, FPLC, Vancouver
"Contact Cements for Wood Gluing," R. F. Blomquist and Warren Olson, USFPL, Madison, Wis.
"The Effect of the Wettability of Wood on the Glue Line Behavior of Two Urea Resin Adhesives," H. G. Freeman and F. Wangaard, Yale Univ. School of Forestry, New Haven, Conn.
"Types of Suitable Adhesives and Gluing Procedures for Fire-Retardant-Treated Wood," Leonard A. Rocella, Roddis Plywood Corp., Marshfield, Wis.

Mater

Jenkins

Lloyd

SESSION 10

LUMBER MANUFACTURING

Tuesday, June 7, 2:30-5:00 p.m.
Program and Presiding Chairman, M. H. Mater, Mater Engineering, Corvallis, Ore. Recorder, Paul Heller, Mgr., Pacific Pine Lumber Co., New Westminster, B. C., Canada. Panel Moderator, Col. J. H. Jenkins, Director, FPL of Canada, Department of Northern Affairs and National Resources, Ottawa, Ontario, Canada.
"The Future of Hardwood Industry in Eastern Canada and Northeastern Canada," George French, Hay & Co., Ltd., Woodstock, Ontario, Canada.
"Economics of a Small Hardwood Sawmill," Don Cuppett, Forester, Union Carbide Chemicals Co., Charleston, W. Virginia.
"The Future of the Lumber Industry in Eastern Canada," Frank Rook, President, Pembroke Shook Mills, Pembroke, Ontario, Canada.
"Cost Reduction in Lumber Handling," J. R. Bemis, Ozan Lumber Co., Prescott, Ark.

SESSION 11

MERCHANDISING

Tuesday, June 7, 2:30-5:00 p.m.
Program Chairman, Prof. William L. [illegible], Dept. of Forestry, Michigan State Univ., East Lansing, Mich.
"Canada Promotes Wood", Cleve Edgar
"Wood Promotion in the U.S." Jerry Pringe,

Preusser

Bryant

Blomquist

SESSION 12

GLUES & GLUING

Wednesday, June 8, 8:30-11:30 a.m.

Program Chairman, Prof. B. S. Bryant, College of Forestry, Univ. of Washington, Seattle.

"Automating Glue Spreading and Lay-up," —Joint panel with Veneer and Plywood Division.

"Automating Possibilities in the Plywood Plant," Henry Preusser, Technical Service Mgr., Adhesives, Resins, and Chemical Division, American Marietta Co., Seattle, Wash.

"Automating Possibilities with Dry Film Glue Line," R. K. Stensrud, Technical Div., Reichhold Chemicals, Inc., Seattle, Wash.

Elliott

Scheffer

Lane

SESSION 13

LOGGING

Wednesday, June 8, 8:30-11:30 a.m.

Program and Presiding Chairman, J. A. Doyle, FPL of Canada, Ottawa.

"Water Spraying to Protect Hardwood Logs from Stain and Decay," Paul H. Lane, Lake States Forest Exp. Sta., Wausau, Wis. and Theodore C. Scheffer, USFPI, Madison, Wis.

"The Development of a Logging Mechanization Program by the Quebec North Shore Paper Co., Baie Comeau, Quebec, Can.

"The Transport of Pulpwood Chips in Pipelines," D. R. Elliott, Pulp and Paper Research Inst. of Can.

"The Integrated Utilization of Southern Pine," T. N. Baker.

Ellis

Fleischer

SESSION 14

INDUSTRY-EDUCATION

Wednesday, June 8, 8:30-11:30 a.m.

Program Chairman, Dr. Everett Ellis, School of Natural Resources, Univ. of Michigan, Ann Arbor.

Panel I: "Vocational Training For Wood Technology," E. Sigurd Johnson, N. C. State College Dept. of Industrial Engineering, Raleigh, N. C.

"Fundamental or Basic Approach in Training for Wood Technology," Dr. H. O. Fleischer, USFPL, Madison, Wis.

"Why Wood Technology Training Should be Offered by Forestry Schools," Dr. George Garratt, Dean Yale School of Forestry.

"Why Wood Technology Training Should be Divorced from Forestry," Dr. Alex Panishin, Mich. State U.

Panel 2: "Relation of the National 'Wood Promotion Program' to Education Training Program," N.L.M.A.

Roberts

Brooks

Stillinger

SESSION 15

WOOD COMPOSITION BOARD

Thursday, June 9, 9:00-11:30 a.m.

Program Chairman, A. L. Mottet, Long–Bell Division, International Paper Co., Longview, Wash.

Presiding Chairman, J. R. Roberts, U. S. Gypsum Corporation, Palatine, Ill.

"Significance of Recent Developments in the Production and Use of Hardboard from the Mill Manager's Point of View," O. B. Eustis, Mgr., Hardboard Plant, Abitibi Corp., Alpena, Mich.

"The Emerite Process of Hardwood and Semi-Hardboard Manufacture," S. Hunter W. Brooks, Emerite Corp., Jackson, Miss.

"Exterior Durability of Hardboard," Edward Ruffin, Masonite Corp., Laurel, Miss.

"Insulating Board Markets and Uses," Claude S. Goyder, International Fibre Bd., Ltd., Montreal, Quebec, Canada.

SESSION 16

QUALITY CONTROL

Thursday, June 9, 9:00-11:30 a.m.

Program and Presiding Chairman, Dr. J. R. Stillinger, Technical Director, Cascades Plywood Corp., Lebanon, Ore.

"Work Sampling Method—In Application to the Logging Industry," Gilbert Tardif, Consultant to Operational Research Group, Quebec North Shore Paper Co., Quebec, Canada.

"Measurement of Machine Capabilities," Edward R. Hansen, Quality Control Statistician, Hamilton Mfg. Co., Two Rivers, Wis.

"Application of Linear Programming to a Sawmill Problem," Norman D. Jackson, Prof. of Forest Utilization, Univ. of West Va., Morgantown, W. Va.

"Effective Use of a Computer—A Case Study," B. C. Borden, Dist. Applied Service Rep., International Business Machines Co., Ltd., Toronto, Ont., Canada.

SESSION 17

WOOD DRYING

Thursday, June 9, 9:00-11:30 a.m.

Program and Presiding Chairman, R. S. Millett, Seasoning Research Division, FPL of Canada, Ottawa.

"The Moisture Content of Building Structural Members in Situ," W. C. Hopkins, Assoc. Prof. of Forestry, La. State Univ., College of Ag., Baton Rouge 3, La.

"Study of Lumber Drying & Quality Control of Moisture Content in Kiln Dried Lumber," Harvey H. Smith, P. O. Box 245, Berkeley, Calif. & John Dittman, Winton Lumber Co., Martell, Cal.

"Fundamentals of the Drying of Wood," A Brief Informal Discussion, Dr. A. J. Stamm, School of Forestry, N. C. State College, Raleigh, N. C.

"Application of Kiln Drying to the Entire Lumbering and Woodworking Industries," G. Billington, Moore Dry Kiln Co. of Can., Brampton, Ont.

"Longitudinal Case-Hardening in Lumber," Dr. Stephen Preston, Dept. of Nat'l Resources U. of Mich., Ann Arbor. Also: Informal discussion on research at FPLC, Ottawa, on kiln-drying of white pine as affected by chemical brown stain and moisture pockets.

SESSION 18

WOOD COMPOSITION BOARD

Thursday, June 9, 2:00-4:30 p.m.

Program Chairman, A. L. Mottet, Long–Bell Division, International Paper Company, Longview, Wash.

Recorder, Dr. Dale Turner, Mgr. of Research, Masonite Corp., Laurel, Miss.

Composition Board Session 2 Particleboard Technical Papers.

Presiding Chairman, Kjell Stordalen, Wynewood Products Corp., Jacksonville, Texas.

"Show-through of Particle Board Cores as Evaluated by a New Technique," Bruce Heebink, USFPL, Madison, Wis.

"Veneer Checking on Particle Board," Dr. M. M. Yan, Supervision, Panelboard Research, Abitibi Power & Paper Co., Sault Ste. Marie, Ont., Can.

"European Development of Particle Board Standards & Testing Methods," Dr. E. Plath, Mgr. Res. Inst. for Woodworking Materials & Wood Glues, Karlsruhe, Germany.

SESSION 19

VENEER & PLYWOD

Thursday, June 9, 2:00-4:30 p.m.

Program Chairman, J. L. Lutz, USFPL, Madison, Wis.

"New Plywood Uses Developed by Structural Research," David Countryman, Chief of Applied Research, DFPA, Tacoma, Wash.

"Commercial Standards for Hardwood Plywood Products," William Groah, Lab. and Inspec. Mgr., Hardwood Plywood Institute, Arlington, Va.

"Linear Programming in the Plywood Industry," Ernest Koenigsberg, Mgr. of Mgmnt. Sciences, Division of Touche, Ross, Bailey & Smart, Certified Public Accountants.

Abstracts of Selected National Meeting Papers

Hansen

Goyder

Measurement of Machine Capabilities

E. R. HANSEN

Hamilton Mfg. Co., Two Rivers, Wis.

The measurement of machine capabilities involves the analysis of the output of a machine to determine its natural or inherent variability. The essence of machine capability studies is to place a numerical value on this variability in order to lay the basic groundwork for an improvement in quality and to help recognize the portion of total variability which can be reduced. Three different techniques of evaluating machine capability are described by examples. The three techniques are: (1) X and R Charts, (2) Multivary charts, and (3) Span Plan method of process capability analysis. The first two techniques are used on more simple problems and the last on more difficult and complex problems.

Insulating Board in Canada

C. S. GOYDER

International Panel Boards Ltd., Montreal, Quebec, Canada

The rapid growth of consumption in the early years (1912–27) has been followed by a levelling off of the rate of progress. The development of the market has been marked by a change in the type of products produced. Ground has been lost to other types of material in certain applications but new uses have been developed to maintain progress. This process continues and future applications for the product are considered.

Cost Reduction in Lumber Handling

J. R. BEMIS

Ozan Lumber Co., Prescott, Ark.

The manhour requirement per thousand feet of production, from log skidway to the finished product in the car, can be substantially reduced. This result may be attained through the use and arrangement of the most modern machinery available, with proper attention to material flow and maximum utilization of raw material.

Exterior Durability of Hardboard

E. T. RUFFIN

Masonite Corp., Laurel, Miss.

The selection of the proper type Hardboard is essential when satisfactoray exterior durability is required. Impregnation of Hardboard in oils and resins followed by baking, as usually practiced in tempering processes, increases many of the board's physical properties but does not necessarily increase its weathering resistance.

Factors which predominately influence Hardboard's exterior durability are: wood species, severity of heat treatment, additives to fiber, degree and uniformity of fiber refinement, degree of consolidation, process of tempering, and severity of exposure.

Hardboard is painted primarily for appearance and secondarily for protection. If properly manufactured and applied, it will perform well in exterior service whether painted or not. High quality, conventional, oil house paints enhance the durability of Hardboard whereas certain of the newer types, formulated for fast drying, low gloss, and high hiding properties, contribute very little to its durability. If these coatings fail prematurely, the Hardboard may be unjustly blamed.

Methods used to evaluate durability in this study were: (1) accelerated weathering (weatherometer) and (2) fence exposure, natural and accelerated.

Bemis

Ruffin

Economics of a Small Hardwood Sawmill

D. G. CUPPETT

Union Carbide Chemicals Co., Charleston, W. Va.

The talk will be a review of our experience in replacing three small circular mills with one automated circular mill designed to cut the log yield of a property of 50,000 acres of hardwood forest land. Included will be unit costs for both types of mills, along with the problems of conversion to automation. Advantages and disadvantages of debarking rather than washing logs, and a simple system of metal detection will be discussed.

The writer will also describe some methods for arriving at the proper size of mill to build in order to achieve a reasonable balance of timber supply, markets, production, and costs.

Let's Face Our Problems

G. E. FRENCH

Hay & Company, Ltd., Woodstock, Ontario, Canada

A discussion of some of the major problems covering the manufacture of Lumber and Plywood in the Northeastern Hardwood Region which have been brought on by the rapid changing economic climate in the last three decades. It deals with the conditions confronting operators in this area.

Cuppett

French

The Future of the Softwood Lumber Industry in Eastern Canada

S. FRANK ROOK

Pembroke Shook Mills, Ltd., Ontario

As in any business many factors influence the future, and in particular five factors will have influence on the future of the softwood industry in Eastern Canada. 1) Demand. Will it be increasing? The answer seems to be that with increasing populations in Canada and the United States, the demand for all sorts of materials including wood will increase. The problem facing wood is, can we reverse a trend to substitute products, either because of quality or price?

2) Will there be sufficient raw materials to meet the demand? With present management techniques improving, it would appear that by 1980 there will still be sufficient softwoods to meet all demands.

3) Competitive position. Lumber is still tending to price itself out of the market because of changes in operating conditions, higher labor costs and increasing transportation costs. The problem may be solved by a change in the type of mills operating and by greater use of sawmill residuals. Undoubtedly Provincial and State Governments may have to assist by changing various Government regulations pertaining to the lumber industry

4) Will financial returns be attractive enough to encourage new investment? The answer cannot be generally "yes" or "no" to this question and will depend largely on individual effort and circumstances

5) Are the marketing and research programs sufficiently organized to ensure a future market for softwood lumber? It is in this area that the lumber industry must improve most. In the main, marketing and engineering programs in the East are practically nonexistent. It is expected that the new lease on life taken by the various associations in advertising their product, together with probable general grade marking of lumber in the next few years, will help towards solving the marketing problem.

Hopkins

Koenigsberg

The Moisture Content of Building Structural Members in Situ

W. C. HOPKINS
University of Louisiana, School of Forestry, Baton Rouge, La.

The moisture content of bottom plates, studs and top plates, in place in buildings in Baton Rouge, Louisiana, was measured over a 12-month period. Some of these buildings were ceiled, others were not. Two of the ceiled buildings were heated, the others were not. Moisture content measurements were made with a Delmhorst Model RC-1 moisture meter fitted with a banana plug cable. Stainless steel screws were placed in the members at five locations and insulated wires lead from these screws to a jack box. Readings were taken by simply plugging the meter into the appropriate jack. Results indicate considerable differences between locations with bottom plates having the highest moisture content and top plates the lowest. The moisture content of wood in the ceiled buildings was consistently lower than in un-ceiled buildings. The wood in heated buildings was somewhat lower in moisture content than in unheated buildings. Seasonal variations in moisture content of wood in this area are of considerable magnitude. Studies of this nature should be expanded. Future work on the effect of various types of wall construction is anticipated.

The Applications of Linear Programming to the Plywood Industry

ERNEST KOENIGSBERG
Touche, Ross, Bailey & Smart, San Francisco, Calif.

The problems of production and purchases which are inherent in any plywood enterprise are complex because of the large numbers of finished products and raw materials required for their manufacture. In an extensive study, described here, an attempt was made to apply linear programming techniques to the industry. These techniques can be regarded as a natural extension of the Mayhew Cost System and it is shown that they provide management with improved information on which to base decisions. The operations most likely to benefit in this way are log purchases, peeling of veneers and the use of veneers to produce a more profitable product mix. Two examples are presented in detail, the aspects of log purchases and product mix decisions being treated independently, and it is shown that the application of linear programming can result in improved performance The models used have been simplified because of a paucity of data and/or in order to fit them to a specific computer The problems are, however, realistic as regards formulations and data, and the only real limit to the size of the problems that can be handled is the time required for computations. It is interesting to note that the solutions have "by-products" i.e., shadow prices, opportunity costs and matrix elements which provide management with a further wealth of information.

The Transportation of Pulpwood Chips in Pipelines

D. R. ELLIOTT
Pulp and Paper Research Institute of Canada

The movement of valuable materials in pipes is a universal practice and in recent years it has been demonstrated that solids can be hydraulically transported in pipelines over great distances. The 108 mile coal line between Cadiz and Eastlake in Ohio and the 72 mile line of the American Gilsonite Company over the Brookcliffe mountains along the Utah-Colorado border are good examples. The Pulp and Paper Research Institute of Canada has used a pilot plant to study the long distance transport of pulpwood chips in pipelines. The objective has been to determine whether or not chip pipelines are practical and economical.

Experiments have been conducted to measure chip deterioration, to measure pipe friction losses and to evaluate mixtures that might be used in practice, since no information was available to calculate such values and predict chip pipeline performance accurately. Because of the many variables that might be encountered in the application of pipelines to long distance chip transport, experimental work has been confined to measurements for extreme conditions, and at the limits of expected industrial practice, on the basis that such measurements would reveal definite or likely failures of such a system of transport.

Results indicate that the long distance transport of pulpwood chips in pipelines, using water as the carrier, is practical and estimates of unit transportation costs suggest that certain chip pipelines will be less expensive to operate than alternative systems of transport.

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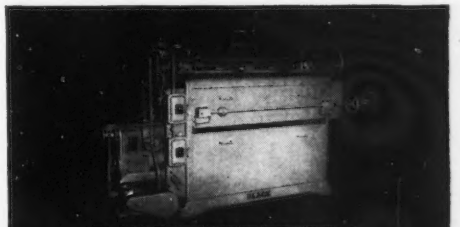

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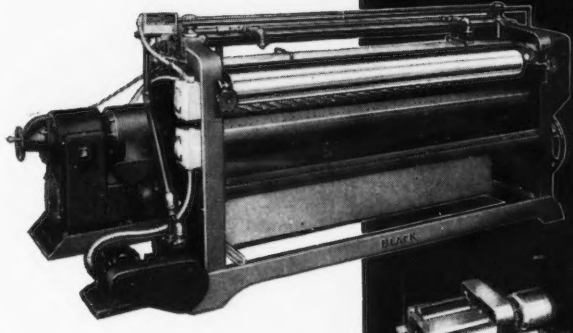

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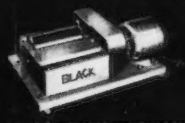

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Veneer Checking on Particle Board

M. M. YAN and WM. G. LANG
Abitibi Power & Paper Co., Ltd., Ontario, Canada

A comparison of veneer checking tendencies in various laminated furniture panels is given, including lumber core and 3- and 5-ply particle board. The effects of a variety of furniture manufacturing variables are discussed and measures for reducing the incidence of veneer checking are recommended. They key to proper performance is limitation of the moisture present in the face veneer at the time of bonding. Some suggestions are given as to the possible origin of the differences between particle board and other panel cores.

The Development of a Logging Mechanization Program by the Quebec North Shore Paper Company

S. J. SIMONS
North Shore Paper Company, Baie Comeau, Quebec, Canada

The limits of the Quebec North Shore Paper Company lie on the North Shore of the St. Lawrence River, running 140 miles to the north from Baie Comeau and Shelter Bay (Port Cartier). Logging methods requiring a large labor force dependent on the expenditure of a great deal of muscular effort and winter snow and ice for horse hauling were becoming too costly by 1952. The industrial expansion in Quebec, the introduction of unemployment insurance benefits and the advent of woods unions added to the problems. By this time it became quite obvious that the QNSPCo would have to change its operating methods. Mechanical operations carried out in the summer and fall appeared to be the best answer.

With this in mind, a program was outlined which called for the development of logging methods to eliminate the manual effort required felling, branching, bucking and piling at the stump, based on a longer operating period (May to December) with a smaller group of more highly skilled, more stable workers. The introduction of company-operated camps, production of peeled wood in the bush and waste utilization were also objectives. The approach followed two main courses: a) the improvement and mechanization of the 4-foot logging operations to eliminate muscular effort of loading and transferring; b) the development of entirely new machines and methods based on the concept of skidding full trees to a process landing for branching, barking and slashing.

An operations research expert was hired who applied these disciplines to our logging problems. By obtaining production and cost data, objective comparisons of various pieces of equipment could be made. Through simulation techniques, accurate forecasts of the production of units planned but not built based on prototype trials were carried out.

The Bombardier HDW Muskeg became the accepted method of handling 4-foot wood in bundles, skidding from the stump to intermediate or final landing up to a maximum 3000-foot haul. The evolution of full tree logging started from a chain-flail device tested in the company's Ontario operations; later, in Quebec, an HDW was used to forward full trees to a small cableway; branching was done by a man using a brush-cutting saw, following which the tree was delivered to a slasher. This was primitive and still involved much muscular effort in branching. Bombardier Snowmobiles and our company next developed a branching jaw—an hydraulically steel "necklace" which, conforming to the tree, literally ripped branches off and which was so successful that it is now being improved to bark the tree as well. This jaw was first used with a high-lead system integrated with a slasher in 1958. By 1959 the wood handling, branching, slashing and chipping of waste was carried out by a single unit known as the Bombardier Processing Unit, consisting of an 80-foot-long conveyor trough, a cable-operated carriage, a branch conveyor and chipper, a slasher saw and 4-foot-wood conveyor. The prototype showed weaknesses, mainly due to light design but a production of 4 cords per hour was obtained for short periods and with improvements could be obtained as an average. A new unit is now being designed for use in 1960.

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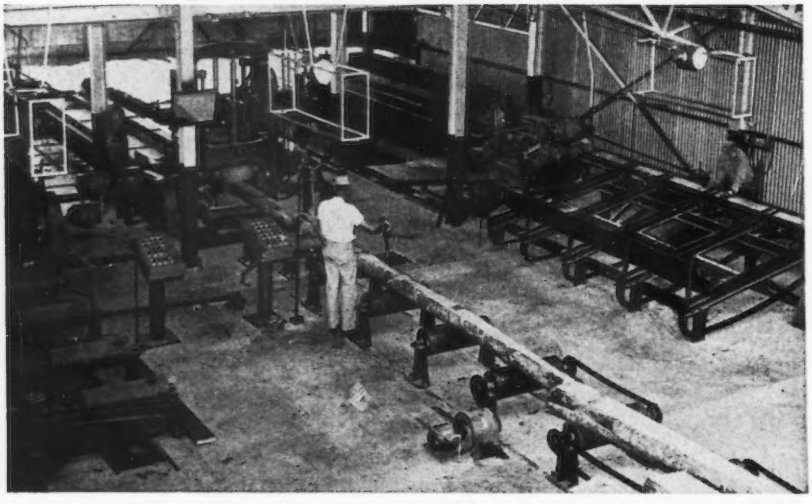

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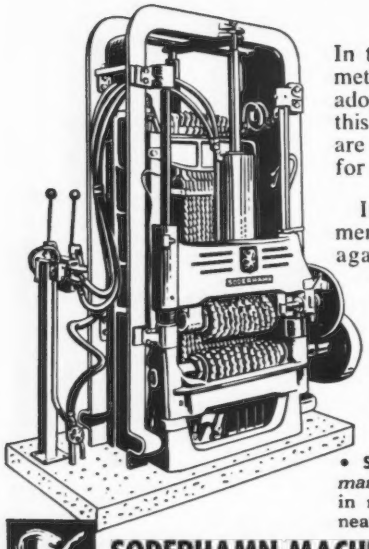

In today's highly-competitive market, all methods of cutting production costs must be adopted if profits are to be maintained. In this situation, worn-out, obsolete machines are costly — down-time and repairs soon pay for new equipment that you never get.

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Work Sampling Method—An Application to the Logging Industry

GILBERT TARDIF
Quebec North Shore Paper Co., Quebec

Work Sampling method basically consists in making instantaneous or snapshot observations at random intervals of time on an operator or machine, and noting if the work characteristics under investigation are taking place or not at the very instant when the observation is made. This technique is compared with the more conventional continuous stop-watch time study method. By means of an example taken from the logging industry, the work sampling method is described and it is shown how standard statistical techniques can be applied with the use of control limits to help detect assignable causes of variation and exert proper control over the production system.

Tardif

Eustis

Significance of Recent Developments in the Production and Use of Hardboard from the Mill Manager's Point of View

O. B. EUSTIS
Abitibi Corp., Alpena, Michigan

The Mill Manager's primary concerns in considering new products and process changes are 1.) cost of manufacture 2.) equipment and space requirements 3.) problems of personnel training 4.) effect on overall flexibility and efficiency of plant operation. Some major process developments in the hardboard industry are the wet process S1S, the wet-dry process S2S and the dry or semi-dry process. As a result of these processes the impact of new products on plant design and operation has resulted in thin boards—below 1/8", thick boards—above 1/4", wider density range, more detailed customer specifications, special sizes—larger than 4' x 6', specially fabricated sizes, and predecorated and prefinished boards.

Comments on a Russian Film on 'Woodcutting'

R. W. PERKINS
Wood Products Eng. Dept., State University College of Forestry, Syracuse, N. Y.

The Soviet film, **Woodcutting**, by E. G. Ivanovsky shows a study concerned with orthogonal cutting under different conditions of cutting angle, chip thickness, grain direction and cutting direction, Very high optical magnifications were used throughout portions of the film, including some shots of veneer cutting and a compression type of scraping. The film, obtained at the College of Forestry, Syracuse University, was produced in 1955 by I. A. Apel at the Motion Picture Laboratory of the Kirov Institute.

Linear Programming in Lumber Production

N. D. JACKSON
University of West Virginia, Morgantown, W. Va.

Time studies were conducted at eleven sawmills, in the Piedmont region of North Carolina, to collect data on the conversion of logs into lumber as affected by log size and operational procedures. These data were analyzed, using the simplex method of linear programming, a method most commonly used to solve problems in which certain limited resources are being converted into saleable commodities subject to stated restrictions. Profit maximization problems were programmed to illustrate the methods by which linear programming can be applied to the sawmilling industry. It is shown that, with data on the limited resources, log supply, operational restrictions and market restrictions, linear programming can be used effectively to arrive at the optimum combination of sawing methods to produce lumber in a manner that will return maximum profits to the owner.

Jackson

Huber

Gooch

Wood Preservative Test Data As a Guide in Establishing Customer Specifications

H. A. HUBER and R. M. GOOCH
Dow Chemical Co., Midland, Mich.

Annual tests conducted on percent of preservative used and amount retained, comparisons of oil carriers and tests of preservative mixtures can provide a customer with information for writing specifications. Case histories of tests on utility poles and crossties are included and will demonstrate the ways that specification writing can be improved and the wisdom of results types of specifications. Such specifications combined with grade-marked, brand-marked treated products will bring increased integrity to the Wood Industry

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Water Spraying to Protect Hardwood Logs from Stain and Decay

P. H. LANE
Lake States Forest Experiment Station, Wausau, Wis.
THEODORE SCHEFFER
Forest Products Laboratory, Madison, Wis.

The problem of decay and stain as sources of waste or degrade in logs is particularly serious in high-value hardwood veneer logs. One method of preventing or retarding the growth of stain fungi in logs is to store them in ponds or spray them with water. However, ponds are expensive to build and maintain, and exposed portions of floating logs are subject to stain and decay.

Spraying decked logs is not a new method of control. Water sprays, although used on western softwoods have not been used extensively for protecting hardwood veneer bolts and sawlogs. In 1959 the U.S. Department of Agriculture, Forest Service and the Birch Club made a spraying study on four hardwood species—sugar maple, soft maple, yellow birch, and white birch. Four methods of spraying were studied: 1.) continuous spraying of entire log surfaces, 2.) continuous spraying of only the ends of decked logs. 3.) intermittent spraying with alternating cycles of 6 hours of complete wetting and 6 hours with sprays off, and 4.) intermittent spraying with 12 hours of complete wetting during the day and 12 hours off at night.

Spraying was started April 20, 1959, and discontinued October 6, 1959. Test piles of winter-cut veneer logs were set up in the yard of the Frost Veneer Company, Antigo, Wisconsin. Continuous spraying gave complete protection from rot and stain, both light and dark were held to very small or negligible proportions. Intermittent spraying gave about as good protection as continuous spraying. White birch was the only species where rot developed during intermittent spraying. No rot was found in white birch receiving continuous or end spraying. This rot in white birch was not considered to be serious.

To determine how much delay could be tolerated in starting spray protection for winter-cut logs, separate groups of sample bolts were left unsprayed on the storage yard until May 15, June 1, and July 1, 1959. Delay tests were confined to yellow birch, white birch, and hard maple. A delay of spraying until May 15 had no significant effect other than to permit a small amount of light stain in the white birch. A delay until June 1 enlarged this stain until its average depth in the sheets was 12 inches, otherwise control of defects was still excellent. In logs not sprayed until July 1, the light stain in white birch averaged 17 inches deep, and the dark stain averaged 8 inches deep. Again there was no consequential stain in the other woods, and there was virtually no visible rot in any species.

The following conclusions may be drawn relative to the control of stain and decay in the four species of hardwoods studied. Continuous spraying will provide excellent protection from decay and stain fungi during warm-weather storage. Spraying will not prevent chemical discoloration commonly occurring in hardwoods, but will retard its penetration into logs materially. Intermittent spraying will proper cycling can provide satisfactory control of stain and decay fungi. This is an important consideration where the water supply is limited.

Creosote-Pentachlorophenol Solution—A Fortified Wood Preservative for Southern Pine Poles

G. Q. LUMSDEN
Bell Telephone Labs., Inc., Murray Hill, N. J.

Early failures of 8-pound creosoted southern pine poles are being reported at a higher rate than was originally presumed, particularly in the South. To reduce the number of low retention (risk) poles either a higher overall retention or the use of a more toxic preservative is indicated. The object is not to increase the average "physical life" of the pole because the average 8-pound by gauge southern pine pole is lasting well in excess of the average "service life". But, by adding 2 percent, by weight, pentachlorophenol to coal tar creosote, the toxic efficiency is increased some 40 percent over that obtained by using either creosote or penta-petroleum alone. This added toxicity will take most individual poles with low retentions out of the risk class. And yet, the chance of bleeding is minimized because the liquid retention level is not increased. The added efficiency of creosote-penta has been demonstrated repeatedly by laboratory soil-block bioassay. Comparative tests in outdoor plots in the South using ¾ inch sapwood stakes further confirm these findings. Tests on pole-diameter posts and poles in line are also favorable, but the period of service admittedly is short.

All southern pine poles for Bell System use are now being treated with this new preservative under a "results-type" specification calling for not less than 6.0 pounds per cubic foot as determined by toluene extraction of the zone 0.5–2.0 inches from the surface of increment cores taken from 20 representative poles per charge. This assay value roughly approximates 8 pounds by gauge. To date approximately one million poles have been treated with creosote-penta solution and shipped to all states east of the Rocky Mountains. The general features of creosote-penta treatment are the same as those with straight creosote treatment. Creosote-penta poles are similar in surface appearance to poles treated to an 8-pound gauge retention with straight creosote. The elimination of early and costly failures of southern pine poles without increasing the risk of getting dirty poles is being accomplished by the use of the creosote-penta solution.

Weathering of Creosote During Exposure in ¾-Inch Pine Stakes

C. W. LEACH and T. W. SMEAL
United States Steel Corporation, Trafford, Pa.

The Applied Research Laboratory of the United States Steel Corporation has developed a method of obtaining evaporation patterns of small (0.1 to 1.0 gram) samples of coaltar creosote. The method is correlated with the standard method of distillation used by the American Wood-Preservers' Association and with Snyder 5-ball column distillation. Changes in the characteristics of creosote extracted from different portions of ¾-inch square southern pine test stakes are shown. It was observed that if the wood is initially well-preserved, and therefore meets customary specifications of the major users of preserved wood, the characteristics of coal-tar creosote in wood can undergo a significant normal change without corresponding loss of protective value. This procedure is another potential tool for use in result-type specifications and for measuring the quality of pressure-treated wood delivered to the site.

Show-Through of Particle Board Cores as Evaluated by a New Technique

B. G. HEEBINK
U. S. Forest Products Laboratory, Madison, Wis.

The purpose of this work was two-fold: (1) Develop a sensitive reproducible technique for evaluating the show-through of core stock, and (2) Evaluate by this technique many variables in particle board core fabrication.

The technique of projecting a grid pattern on a kerosene-coated plastic surface and observing (or photographing) the reflected image focused on a translucent screen was found to be highly sensitive, independent of surface grain or pattern, and reproducible. Furthermore, the apparatus can be made portable for use on finished furniture.

A limited number of variables one at a time, were evaluated by comparison with a standard ½-inch particle board 40-pound density, made from 1-inch long, 0.015-inch-thick random-width Douglas-fir flakes, and 8 percent urea-resin binder.

Variations in the core such as moisture and resin content, density, shavings vs. flakes, and aspen vs. Douglas-fir, had little or no effect on the show-through characteristics. The use of fines on the surface, rubber cauls in hot pressing, and elimination of sanding produced considerable improvement in decreasing the show-through pattern. Particles such as slivers and thick flakes degraded the surface.

Further work revealed improvement when redwood flakes were used particularly with unsanded fines on the surface). Edge-grain Douglas-fir flakes were better than flat-grain Douglas-fir flakes. Crossbands of 1/16-inch veneer were ineffective, but a ⅛-inch hardboard crossband improved the surface. Sanding with a sandpaper-covered steel drum produced a better surface than sanding with felt-cushioned discs. There appeared to be no relation between average thickness swell and show-through.

Many variables remain to be evaluated: however, the promising leads covered in this work could initiate commercial development work towards better particle board cores.

L'Oratoire St. Joseph, known as Brother Andre's Shrine attracts 4 million pilgrims and visitors a year.

Air view of the heart of Montreal. Queen Elizabeth Hotel is at (9). To the right (8) is the St. James Cathedral.

Montreal is Ideal Setting For F. P. R. S. Meeting

If the subject matter of the FPRS national meeting is not sufficient inducement to attend, the setting—namely Montreal—should tip the scales in favor of a 100 percent attendance.

Montreal, named after the extinct volcano which rises in the midst of the city, can offer the visitor everything. Historical background, thriving industry, sports, gorgeous scenery, heart-warming hospitality—all these add up to "Montreal". What a grand opportunity to combine business with pleasure from June 5–9 (or longer)!

Montreal was the birthplace of Pierre Le Moyne D'Iberville, founder of Louisiana, and of his brother Bienville, founder of New Orleans. Repentigny, nearby was the birthplace of Salomon Juneau, founder and first mayor of Milwaukee. Here too lived LaMothe–Cadillac, founder of Detroit and Duluth, explorer of the Dakotas.

It is not possible to compress within the limit of this small space the growth of Montreal from an Indian village in 1642 to the second largest French-speaking city in the world, and the second largest seaport in North America, although located some 800 miles from the Atlantic Ocean.

Although a veritable treasure-house of historical lore, the city is in every respect a modern one. With a population of well over one million it is the industrial, commercial and financial center of the Dominion. More than three-quarters of the inhabitants of Montreal speak French as their native tongue. They and their English-speaking fellow citizens have a well-deserved reputation as dispensers of a warm and charming hospitality.

For the ladies, shopping in Montreal has a variety matched by no other city. On busy Ste. Catherine Street are the large department stores and town specialty shops. On Sherbrooke Street, the visitor discovers the fashionable establishments that have given this thoroughfare the title "Montreal's Fifth Avenue".

The surrounding countryside is ideal vacation land. Within almost a stones throw of the Queen Elizabeth Hotel one may see the mighty St. Lawrence seaway development. Ottawa, the capital of Canada is distant only 120 miles and Quebec City to the east—the only walled city in North America—has a charm all of its own. This truly old-world city seems to have its rich historical background of war, romance, and the courage of pioneers forever reflected in the aged cliffs and delightful countryside. Founded in 1608 by Samuel de Champlain it was the home of men who pioneered on the Great Lakes and the Mississippi. Winding and twisting upwards around the Rock, its narrow streets are a unique spectacle on this continent.

Pour les femmes . . .

Social activities for ladies planned by Mrs. P. R. Le Sage begin Sunday evening with the Host Section Reception. Monday's program includes a morning coffee hour. Monday afternoon features a tour of Montreal, second largest French-speaking city in the world. Bilingual Canadians will be delighted to help you brush up your French. Tuesday features morning events, the Ladies Breakfast and FPRS Luncheon. The afternoon is free for sightseeing trips perhaps to Saint Joseph's Oratory, Notre Dame, or other famous Montreal cathedrals. Wednesday features a Fashion Show presenting designs by Raoul–Jean Foure and a Ladies Luncheon. Evening events include the Paul Bunyan Cocktail Party and the FPRS Banquet with entertainment and dancing in the luxurious Grand Salon.

Dress and Climate in Montreal

In June Montreal's mean temperatures are maximum 74° and minimum 56°. Since it is a continental-type city light weight dark wool suits and dresses with hat and gloves are proper for daytime. It would be wise to include a dark silk dress, raincoat and warm wrap for evening. An interesting shopping note is that luxury import items such as perfumes are less expensive in Montreal than in the United States.

Thirteen Wood Award Entries Confirmed

The annual Wood Award Competition sponsored by Wood and Wood Products Magazine for the past 12 years, will have at least 13 entries this year, according to Dr. Everett Ellis, Chairman of FPRS Industry-Education Division, and J. F. Koellisch, Editor and Manager of Wood and Wood Products.

Entries have been confirmed from the following schools: New York State University, University of British Columbia, University of Michigan, Plant Research Institute of Ottawa, North Carolina State College of Forestry (2), Yale University, University of Illinois, Colorado State University, and Oregon State College (3).

The following tentative titles have been submitted:

"The Effect of Repeated Loading on the Tensile Properties of Wood;"
"Some Anatomical Features Related to Permeability of Douglas-fir Wood;"
"Comparison Between Herbert's Equation for Outer Fibers of the Beam and the Stress-Strain Diagram of Douglas-Fir;"
"Dimensional Variation in Lumber Manufactured in Colorado;"
"Fundamental Aspects of the Wood Machining Process";
"Some Factors Affecting Resin Efficiency in Wood Flakeboard;"
"Crystallinity of Wood Cellulose Fibres by X-ray Methods;"
"Gamma Rays for Determination of Wood Density and Moisture Content;"
"The Symbiotic Action of Two Fungi in the Deterioration of Treated Wood;"
"Visual Criteria of Quality in Spruce Wood;" and
"Holocellulose Determinations of Mountain Hemlock Bark;" and
"The Resistance of Casein Glue Joints in Wood to Fatigue Stressing;" and
"Ten Effects of Selected Variables on the Properties of Flat-Pressed Flakeboard."

A $350 cash award will be granted the first-ranking research paper submitted, and a $150 award will go to the paper selected second by the judging committee. Winners will be announced at the 1960 National Meeting in Montreal.

Candidates for National Office

R. H. Berry

D. K. Saunders

T. S. Veazey

E. S. Harrar

E. A. Anderson

K. O. Roos

R. J. Seidl

E. M. Williston

Candidates for national office of the 4,100 member Forest Products Research Society have been announced. Results of the election will be released at the Society's 14th National Meeting, June 5–9 in Montreal.

Raymond H. Berry, current President-Elect, will automatically become President in June, succeeding Dr. E. S. Harrar, Dean of the Graduate School of Forestry, Duke University. Dr. Harrar will remain on the Executive Board as Past President.

Mr. Berry is vice-president and general manager of the Scott Lumber Company. A graduate of Yale College and Law School, he has served on the National Executive Board since 1955 as Southwest Regional Member, Vice-President, and President Elect. In June 1959 he served as General Chairman of the FPRS National Meeting at San Francisco. This year he is Chairman of the Technical Program for the forthcoming Montreal meeting.

Candidates for other offices are:

President Elect: Donald K. Saunders, president of Saunders Brothers, is currently serving as FPRS Vice-President. A graduate of Dartmouth, he has been Chairman of the Northeast Section, Northeast Regional Board Member, and is currently General Chairman of the forthcoming National Meeting in Montreal. He is Coordinator of the Society's 14 Subject Matter Divisions.

Vice-President: Tony S. Veazey, research engineer, Anaconda Company, a Montana School of Mines, graduate, has served as Pacific Northwest Regional Board Member for three years and is FPRS National Membership Chairman. He has played an important role in the selection of Spokane as the site of the Society's 16th National Meeting in 1962.

Northeast Regional Board Member: Dr. Eric A. Anderson or Kenneth O. Roos. Dr. Anderson, graduate of the University of Washington and Chairman of the Department of Wood Technology, State University of New York in Syracuse, has served as the Chairman of the Northeast Section. Kenneth O. Roos, a University of Toronto graduate and a former Chairman of the FPRS Eastern Canadian Section, is vice-president and general manager of Booth Lumber, Ltd.

Northwest Regional Board Member; Robert J. Seidl or Edward M. Williston. Robert J. Seidl, Director of Research of the Simpson Logging Company, is a graduate of the University of Wisconsin. For a number of years he was the Assistant Chief of the Division of Pulp and Paper of the U. S. Forest Products Laboratory, Madison, Wisconsin. Edward M. Williston, a graduate of Pennsylvania State University, is Manager of Product Development, Technical Center, Weyerhaeuser Company, Longview, Washington. He has served as trustee of the Pacific Northwest Section and has been a contributing author to the FPRS national and sectional meetings.

Pacific N'West Meeting Eugene, Ore., May 9-10

Spring meeting of the Pacific Northwest Section will be highlighted by one technical session devoted to finishing problems and a second that will cover composition boards, genetics, fiber properties, and the operation of hardboard and particle board plants.

Area tours will also be made to the J. H. Baxter Co. treating plant, the Giustina Plywood Co., and the lumber edge gluing and Ply-veneer operations of Weyerhaeuser Company.

Local arrangements will be made by Paul Walsh, and the technical program is under the direction of Ed Clarke. Registration will take place at 8:00 a.m., Monday at the Eugene Hotel.

Guest speaker at the dinner banquet will be Dr. J. A. Hall, retired director of the U. S. Forest Products Laboratory who will discuss "Utilization in the Northwest —Past and Future."

The technical sessions will cover the following subjects:

Monday, May 9, 1:30 p.m.
Technical Session No. 1

1. "The Factory Treatment of Redwood Siding" by Don Laughnan, Coatings Research Chemist, Simpson Timber Company, Seattle ,Washington.
2. "Some Problems Accompanying New Concepts of Exterior Wood Finishing," by Bob Carlson, President, Cascade Paint Company, Portland, Oregon.
3. "Coating Equipment for Factory Application," by C. B. Luding, Engineer, Weyerhaeuser Company, Longview.
4. "Function of Custom Finishing in the Northwest," by T. J. Welsh, President, Welsh Panel Company, Longview

Tuesday, May 10, 9:00 a.m.
Technical Session No. 2

1. "Utilizing Douglas-fir Bark to make Composition Boards Without Additives," by C. H. Burrows, Technologist, Oregon Forest Research Center, Corvallis, Oregon.
2. "Genetic Improvement of Wood Quality—Progress and Problems," by John W. Duffield, Technical Director, Industrial Forestry Association, Nisqually, Washington.
3. "Some Mechnical Properties of Wood Fibers in Tension," by Dr. B. A. Jayne, Technologist, Washington State University, Pullman, Washington.
4. "Evolutionary Operation Worksheet for Hardboard and Particle Board Mill," by C. R. Cox, Research Chemist, Monsanto Chemical Company, Se[illegible]

Mid South Section Adopts Student Award Program

At its March meeting, the Executive board of the Mid South Section formally adopted a program for the presentation of membership awards to outstanding students enrolled in forest products technology at specified colleges and universities within the section boundaries.

A $50 cash award will be presented each year for the best student paper submitted on any phase of wood utilization. The papers will be judged by a committee composed of the Section Chairman, Vice-Chairman, and the Chairman of the Section's Industry-Education committee.

Additional awards of one-year memberships will be awarded to two students of each school who are considered outstanding because of their academic records, interest in forest products, personality or professional promise. Candidates will be selected by a faculty committee.

The following schools will participate: Louisiana State University, Louisiana Polytechnic Institute, Arkansas Agricultural & Mechanical College, University of the South, Stephen F. Austin State College, Mississippi State University, and Oklahoma State University.

Executive Board Proposes Dues, Services Increase

. reported in the "President's Colum" on page 3-A, by Raymond Berry, Act g President, the Society's Board of Di tors, at its January meeting voted to rec mend to the general membership a due increase from $15.00 to $20.00 per vot g and associate member.

e need for additional operating revenue has become widely apparent, as printing postage, office supplies, and other ove ead costs have continued to rise in rec t years, and, more importantly, the Soc ty itself became more complex in its erations, necessitating additional services particularly an expanding Journal.

A y change in the dues structure requir s a Constitutional amendment, which mus be presented at the annual business mee ng of the Society, and if approved by a m jority vote there, ratified subsequently by m ail ballot.

It is proposed to amend Article V, Section 3, which now reads, "Dues for voting and associate members shall be $15.00 per year, $2.00 of which will be returned to the Sections to help defray administrative expenses. Annual dues for the fiscal year will be due and payable on or before January 1 of each year. Voting, associate, and student members joining up to and including December 31 shall receive all back publications to which they are entitled for that fiscal year." to . . .

"Dues for voting and associate members shall be $20.00 per year, $2.50 of which will be returned to Sections to help defray administrative expenses. Dues for a one-year period will be due and payable on or before the first day of the month in which a member is accepted for membership. Thereafter his yearly dues will be due and payable on or before the first of the month of joining. Members shall be entitled to all publications for a twelve-month period from date of joining."

Note: Annual dues for supporting members, $100, and for student members, $3.00, remain unchanged.

A corollary Constitutional amendment proposed by the Executive Board at its November, 1959 meeting, and to be voted on at the 14th annual business meeting, concerns the legal establishment of Divisions within the Constitution.

It is proposed to add a new Article XI, which would read, "Article XI—Subject Matter Divisions.

Section 1. Subject Matter Divisions of the Society may be authorized by the Executive Board as provided in the By-Laws.

Section 2. Each Division shall have as division officers at least a chairman, and a vice chairman who shall keep the Executive Board and the Vice President, as Division Coordinator, informed of Division Activities, and such other officers and sub-committees as may be necessary.

Section 3. The Executive Board of the Society will set up such Division By-Law as may be necessary.

ection 4. Every member of the Society in good standing is automatically entitled to membership in the Divisions in which he indicates an interest. Any member may affiliate with other Divisions if he so desires, or attend any division meetings on the same basis as members of that Division.

Section 5. The Executive Board shall have the right at any time to revoke the Authorization of any Division and to terminate its existence. A division whose authorization has been revoked by the Executive Board shall have the right to appeal its case to the Society, at any regular or special meeting of the members."

Present Articles XI, XII, XIII, XIV, and XV would become, respectively. Articles XII, XIII,, XIV, XV, and XVI.

The establishment of Divisions and their operating procedure, are further provided-for in the By-laws of the Society, as approved by the Division officers and enacted by the Executive Board.

Article VIII—Subject Matter Divisions

Section 1. Subject Matter Divisions of the Society may be authorized by the Executive Board upon its own motion or written petition of 15 or more Voting Members.

Section 2. Division Members shall be members of the Society.

Section 3. Divisions shall hold a meeting annually in connection with the annual national meeting of the Society, and may hold such added meeting as divisional officers may desire.

Section 4. Division Officers shall be members of FPRS and shall be elected by those attending the Division Meeting at the Annual Meeting of the Society.

Section 5. The Division Chairman shall submit to the Division coordinator annually a report of Division activities and organizationfor publication in the Forest Products Journal. This report shall be submitted within 30 days after the annual meeting.

Section 6. The officers of each Division shall have the responsibility of working with the President-Elect (National Program Chairman) as representative of the Executive Board in preparation and operation of the Technical Session Program of National Meetings or the programs of such added meetings as the Board shall designate and authorize. Each Division's technical program for the annual meeting shall be completed at least four months prior to the annual meeting date; and copies of all papers be in the hands of the President-Elect at that time.

Section 7. The chairman of each division shall present an annual report to the Society on such research and developments as have taken place within its field of interest during the year. The initial report of a newly formed division shall present a comprehensive statement of the current status of research and development activities within its field of interest.

Section 8. Each division chairman shall appoint a member of his division from each section to act as division representative in that section. This representative's duty shall be to maintain liaison between the division and section organizations, and to advise and assist the section officers in preparing technical programs for meetings, or in other matters which might reasonably fall within the field of interest of his division.

Article IX—Committees

Section 1. The duly elected chairman and secretary of the local sections shall constitute a Section Officer's Advisory Committee.

Section 2. The duly-elected officers of the Subject Matter Divisions shall constitute a Division Officer's Advisory Committee.

Section 3. The Section Officers' Advisory Committee and the Division Officers' Advisory Committee shall each meet separately with the Executive Board at the time of the annual meeting of the Society. The functions of these Committees and of these meetings shall be to maintain close liaison between the local sections, or the divisions, respectively, and the Executive Board for the purpose of coordinating policies, needs, and development among local sections or divisions and between them and the Executive Board.

The proposed Constitutional amendments will be submitted, by mail to the entire voting membership, and presented for adoption at the 14th Annual Business Meeting in Montreal, June 6.

Northern California Section Spring Meeting, April 28–29

The spring meeting of the Northern California Section, FPRS, will be held at the Sheraton Palace Hotel, San Francisco, April 28–29, 1960. A banquet will be held the evening of April 28 at 7 p.m. Acting President of the FPRS, R. H. Berry, Scott Lumber Company, will speak on "Society Affairs"; and H. O. Banks, Director of Department of Water Resources, State of California, will speak on "Development of California Water Resources." The program will include:

Session I, 9:00–11:30 a.m., April 28

"Log Allocation for Most Profitable Use," I. Mann, Simpson Logging Company.

"Raw Material Supply for the Plywood Industry," J. R. McGuire, Pacific Southwest Forest and Range Experiment Station, Berkeley, California.

"Developments in Plywood," H. Evans, Douglas Fir Plywood Research Assn.

Session II, 1:30–4:00 p.m., April 28

"Relation of Glue Line to Plywood End Use," H. Preusser, American-Marietta Company, Seattle, Washington.

"Factory Finishing," W. McKim, Finishing Consultant, Florence, Oregon.

"Plywood Specifications," D. Countryman, The Douglas Fir Plywood Assn.

Session III, 9:00–12:00 a.m., April 29

Plywood Fabrication

"Competition Which Plywood Encounters in the Markets," J. Zeigler, Arthur D. Little Company, San Francisco, California.

Status of the Plywood Industry

Session IV, 2:00–4:00 p.m., April 29

Tour of Forest Products Laboratory, University of California, Richmond.

FPRS Financial Statement, Fiscal Year 1959

FOREST PRODUCTS RESEARCH SOCIETY OPERATING STATEMENT—ACCRUAL BASIS—FOR YEAR ENDED DECEMBER 31, 1959

Operating Income:		
1959 Membership Dues	$49,646.88	
Publication Income	31,961.12	
Dues Collected for Sections	5,162.00	
Services to Sections	1,642.89	
Dividend Income	131.59	
Miscellaneous Income	121.45	
Executive Office Building Contributions	1,017.00	
1959 National Meeting	24,557.44	
Total Operating Income		$114,240.37
Operating Expenses:		
Salaries	31,813.25	
Employer's Social Security	648.11	
Executive Annuity Program	1,053.53	
Insurance and Bonding of Staff	409.75	
Executive Secretary's Medical Allowance	300.00	
Postage, Telephone, and Telegraph	3,566.45	
Supplies and General Office Expenses	4,317.71	
Travel-Secretary and Staff	1,954.57	
Executive Board Expense	743.35	
Membership Campaign	1,742.04	
Service Expenditures for Sections	821.64	
Membership Dues Paid to Sections	5,162.00	
Publication Expense	32,774.03	
Utilities and Janitorial Services	1,124.50	
Real and Personal Property Taxes	1,504.65	
Reserve for Building Maintenance	611.59	
Depreciation of Executive Office Building	1,890.59	
Depreciation of Furniture and Equipment	912.24	
1959 National Meeting	20,865.87	
Total Operating Expenses		112,215.87
Net Income		$2,024.50

FOREST PRODUCTS RESEARCH SOCIETY BALANCE SHEET DECEMBER 31, 1959

Assets

Current Assets:			
Cash in Banks and Savings and Loan Shares		$4,175.68	
Northwest Airlines Credit Card Deposit	$425.00		
Postage	63.59		
Accrued Dividend Receivable	64.00		
Accounts Receivable	4,052.79		
Executive Office Building Contributions Receivable	124.00	4,729.38	
Supplies and Prepayments:			
Paper and Membership Material Inventory	3,056.27		
Annual Proceedings and Journal Inventory	1,000.00		
Prepaid Executive Annuity Premium	149.57		
Prepaid Insurance	1,263.05		
Travel Advance	25.00		
National Meeting Advance	1,000.00	6,493.89	
Total Current Assets			$15,398.95
Fixed Assets:			
Executive Office Building	47,852.63		
Less: Allowance for Depreciation	2,835.88	45,016.75	
Executive Office Building Lot		10,070.60	
Furniture and Equipment	11,848.01		
Less: Allowance for Depreciation	4,296.35	7,551.66	
Total Fixed Assets			62,639.01
Total Assets			78,037.96

Liabilities and Net Worth

Current Liabilities:		
Accounts Payable	6,395.61	
Prepaid Membership Dues	2,013.25	
Accrued Real and Personal Property Taxes	1,504.65	
Reserve for Building Maintenance	611.59	
Total Current Liabilities		10,525.10
Net Worth:		67,512.86
Total Liabilities and Net Worth		78,037.96

Carolinas-Chesapeake Appoints R. C. Garrison

Robert C. Garrison, Garrison Machine Co., Statesville, N. C., was recently appointed chairman of the Carolinas-Chesapeake Section. Garrison replaces John B. Hayward, Perkins Glue Co., who has been appointed sales manager for Perkins' Canadian area.

One of Chairman Garrison's first moves was to call a board of directors meeting to plan for "the biggest and best section meeting yet." Site of the next annual meeting of the Section will be Raleigh, N. C., on the campus of North Carolina State College, where a new $250,000 wood products laboratory was just completed.

Northeast Plans Quality Control Clinic in May

The Northeast Section, in cooperation with the University of Massachusetts and the Vermont Bureau of Industrial Research, will hold a one-day clinic May 19 on "Quality Control in Production Woodworking." The meeting will be held at the Colonial Hotel, Gardner, Massachusetts.

The program, which will demonstrate practical methods, processes, and techniques to assure quality, will be moderated by Jack Saunders, Quality Control Supervisor, A. G. Spaulding & Bros., Chicopee, Mass. The following topics will be covered:

Lumber Procurement—Gordon Bullard, Asst. Chief Inspector, NHLA, Greenfield, Mass.; **Machining**—Paul Graham, Clinic of Wood, Newfane, Vt.; **Gluing**—Robert Snyder, Director of Research, Franklin Glue Co., Columbus, Ohio; **Sanding**—Steven Blake, National Wood Working Engineer, Behr-Manning Co., Troy, N. Y.; and **Finishing**—T. I. Kyle, Industrial Finishing Specialist, Marshall Laboratories, E. I. Du Pont, Philadelphia.

The evening dinner, from 6:00 to 7:30, will feature a nationally prominent speaker, and, from 8:00 to 10:00 in the evening, an open panel discussion will be held with all afternoon speakers participating.

Registration and dinner fee will be $5.00. For reservations mail check to Ronald Gale, Vermont Bureau of Industrial Research, Northfield, Vermont.

Other Northeast activities included two meetings scheduled late in April.

District Meeting

A First District Meeting was hosted by the West Virginia Pulp and Paper Co., in Tyrone, Pa., April 22. Morning and afternoon sessions consisted of tours through the WVP&P paper mill and building board division. The evening session included reports on "Internal Bond—Its Importance and a Rapid Test Method," C. R. Morschauser, WVP&P Director of Product Development; and "Fundamental Board Research at Pennsylvania State University," R. N. Jorgensen, Asst. Prof. in Wood Technology.

The evening session concluded with a panel discussion of "Research, Production, and Consumption of Building Boards." Kermit Forsgren, President, Crescent Furniture Co., Warren, Pa.; John Churchill, Plant Superintendent, West Virginia Pulp and Paper Co., Tyrone, Pa.; and Messrs. Jorgensen and Morschauser participated.

Joint Meeting with ASTM

On April 27 in Syracuse, N. Y., a meeting on non-destructive testing was held jointly with the Central New York District of the American Society for Testing Materials. The program featured tours of the Wood Products Laboratory, and the Pulp and Paper Laboratory at the State University College of Forestry at Syracuse. The feature address on "Non-Destructive Testing," was given by Dr. Albert G. H. Dietz, Professor of Building Engineering and Construction, Massachusetts Institute of Technology.

OVER 70 MEMBERS of the Mid-South Section, and guests from 10 states met in Beaumont, Texas, October 11–13 for their 11th Annual Meeting. In addition to the technical program, tours were made of the Kirby Lumber Corp. at Silsbee and of the East Texas Pulp and Paper Co. at Orange. Among the speakers, upper right, were, J. S. Daniel, Paul R. Kramer, S. H. Brooks, T. Baker and J. O. Holekamp. Below, speakers John Aram, Weyerhaeuser Co., Sam Nickey Jr., Nickey Bros., and R. V. Hansberger, Boise–Cascade Corp.

Mid South Sponsors European Flight

Members of the trip to Hannover, Germany sponsored by the Mid South Section of the Forest Products Research Society leave New York City April 29 for a 2-week visit to Europe via Lufthansa Airlines. Highlighting the trip is a visit to the Hannover Machinery Fair.

Grace Hunt, Executive Secretary of Wilco Machine Works and coordinator of the trip, reports that 82 members of the Society are taking the flight. Due to the enormous enthusiasm for the trip, plans are being made to sponsor it annually for each section. The next trip, a jet flight, is tentatively scheduled for spring 1961.

J. J. Allegretti to Head Division of Scott Lumber

The establishment as of April of a new Special Products Division was announced by Scott Lumber Company, Inc. of Burney, California. Heading the new division is J. J. Allegretti, formerly Manager of Product Development and Market Research for Masonite Corporation, where he was engaged for fourteen years in research, product development, sales and production. Prior to his association with Masonite, Mr. Allegretti spent many years in the forest products field, and during World War II was on the Research Staff of the U. S. Army's Radar Laboratories in New

Jersey. He is a graduate in wood technology of the University of Idaho and has been active in professional associations in the research and wood products fields. The objective of the new Scott division under Mr. Allegretti's direction is to expand the distribution and sales of wood by-products presently manufactured by the company, as well as to foster research on and development of future products.

Rocky Mountain Section Salutes Colorado State

At the February meeting of the Rocky Mountain Section in Fort Collins at Colorado State University new Wood Utilization Laboratory, the following resolution was unanimously adopted:

"Resolved that the Forest Products Research Society extend to President Morgan of The Colorado State University and to Dean Wasser of the School of Forestry the very grateful appreciation of this Society for the authorization, consideration, and support in the establishment and operation of the Wood Utilization Laboratory, that this Laboratory will be of great benefit to the Lumber Industry of Colorado, to all those who are interested in the future of wood with its proper utilization and the objectives of this Society. To request that you extend to Professor Harry Troxel the sincere appreciation of this Society for the very diligent and wonderful efforts that he made to make the Laboratory come up to the very high standards that were set, and to his work in obtaining the contributions of the lumber industry and suppliers in Colorado and the very favorable impressions that he made with the contributors."

In transmitting the resolution to Dr. W. E. Morgan, President, Colorado State University, Dr. E. S. "Scotty" Harrar, FPRS President, congratulated Dr. Morgan on behalf of the entire Society.

"Members of this Society that have had the privilege of visiting the Laboratory have been very high in their praise of the general plan and the work that is now being done toward the objectives in the proper use of wood," he said.

MERCHANDISING of Lumber and Wood Products, was the theme of the Great Lakes Section meeting in Detroit, Oct. 6, 7. Bill Lloyd, program chairman, left, introduces a number of the guest speakers.

OTHER GREAT LAKES speakers included John Reno, Pacific Lumber Co., second from left; and far right, Dr. Alex Panshin, B. S. Hartung.

Section Chairman Sam Tamminga, President "Scotty" Harrar and Steve Preston.

"Next 50 Years In Research" Is Theme of USFPL's Golden Anniversary

Madison, Wis.—Many of the nation's foremost figures in the world of wood will gather here June 2–4 to join with the staff of the U. S. Forest Products Laboratory in observance of its Golden Anniversary.

In announcing the program for the three-day observance, Director Edward Locke commented that virtually all the forest products industries, as well as education, science, and government, would be represented by speakers or participants in other events.

Locke

Weyerhaeuser

Whitaker

"I am extremely gratified," Dr. Locke said, "by the warm, wholehearted response to our announcement that we're planning a birthday party. It speaks well for the cohesiveness and mutual understanding of our common cause among the various branches of our forest products family."

Stressing the theme, "Forest Products Research—the *Next* Fifty Years," four top industry executives will examine the significance of research to the lumber, plywood, pulp and paper, and chemical industries in one of the highlight events on the program.

At the Friday morning session in the University of Wisconsin's beautiful Memorial Union theater, Dr. C. A. Elvehjem, University president, will deliver a major address, "Research in Today's World."

Difford

McArdle

Garatt

He will be followed by F. K. Weyerhaeuser, board chairman of the Weyerhaeuser Co.; H. E. Whitaker, board chairman of the Mead Corp., Dayton, Ohio, and president of the American Paper and Pulp Association; W. E. Difford, managing director of the Douglas Fir Plywood Association; and Samuel W. Lenher, vice president and adviser for research of E. I. dupont de Nemours and Co., Wilmington, Del.

The Golden Anniversary party will start with a banquet Thursday night, June 2, in the University's Memorial Union.

George A. Garatt, dean of Yale University's School of Forestry at New Haven, Conn., will be banquet toastmaster, and Richard E. McArdle, Washington, D. C., Chief of the Forest Service, will speak on the role of research in forest management.

Friday afternoon's program, Director Locke said, will consist of Laboratory tours for guests and special dedication ceremonies highlighting various research achievements that have gained industrial prominence. Evey research division will have special exhibits and demonstrations of its work on view. The program will be concluded with an all-day public Open House Saturday, June 4, at which exhibits and demonstrations will also be on view.

Research News from Forest Products Labs of Canada

Carboxymethylcellulose—Derived From Wood

Carboxymethylcellulose is widely used as a thickener and stabilizer for creams and emulsions. Cellulose has to be rather stable and water-resistant to fulfill this role; a slight chemical modification can change cellulose into a compound which very readily forms colloidal solutions. They are ideal ingredients for processed foods in that they are colourless, tasteless and non-toxic. Carboxymethylcellulose is also used on a large scale in the manufacture of detergents, fire extinguishing materials (foams) and others. Research work at the Forest Products Laboratories of Canada in the field of Wood Chemistry is concerned with improved methods of preparing cellulose and cellulose derivatives

Gluing Western Yellow Cedar

The ability of the more common lumber species to form satisfactory bonds with various types of adhesives has been widely investigated. Major attention has been given to those species which are most favoured for structural applications. Until recently, western yellow cedar(Chamaecyparis Nootkatensis) was not of sufficient importance as to attract more than cursory consideration. A demand for more information has accompanied its increased use in structures. The Vancouver Laboratory is conducting a survey of those problems and will investigate them in their order of importance. Findings will be released as soon as reliable information is available.

Outdoor Chip Storage

A trend in pulp and paper is to bark and convert pulp bolts to chips and to store these in large piles in the mill woodyard. Reports studied by the Ottawa Laboratory indicate that green chips may be stored for four or five months in the summer without significant deterioration Care should be taken to make the piling area as well drained and level as possible, that old chips which may contain decay and stain can be removed before new pile is started. Infected chips will quickly reinfect the new chips and increase their rate of deterioration. The ground should be sprayed thoroughly with one of the toxic chemicals commonly used to prevent blue stain and decay.

New Chemical Compound

Some of the very useful characteristics of cedar are due in large measure to the wood's unusually high content of extractives. The Vancouver Laboratory embarked on a comprehensive study of these extractives several years ago. A number of new organic chemicals were discovered. One of compounds had most unusual properties and structure. It very readily attacks copper metal and being steam volatile, is responsible for the green deposit that forms on copper fittings and controls in kilns used for drying cedar products. The chemical work is described in a scientific paper "Occurrence of 7-Hydroxy-4-isopropyltropolone in Western Red Cedar".

Identification of Wood

An important field of the investigations undertaken by the Laboratories is the study of the anatomy of wood. Each timber species has a typical structure that determines its characteristic properties and uses to which it is best adapted. Wood has long been marketed according to its botanical species to insure that its users will obtain material of recognized standards of uniformity. The indentification of wood can be complicated if its normal appearance has been altered by processing or chemical treatment. Though the superficial appearance may be altered the anatomical structure remains recognizable under suitable magnification. The FPLC is enabled to assist wood users by employing microscopic observation to identify unknown wood materials.

UPPER MISSISSIPPI VALLEY Section speakers, last fall at the Roddis Corp., Marshfield, Wis., included, Paul Lane, Teel Williams, Bob Larson and host Leonard Ropella.

Second and third photos show part of group of 66 persons in attendance.

NEW PRODUCTS and Literature

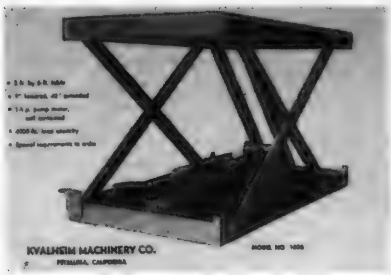
Roddis Announces New Panel

A new development said to give exceptional protection to wood has been announced by Roddis Plywood Corp, Marshfield, Wis. Trademarked TIGACLAD, the surface properties of the laminate are the result of a special sheet that has been impregnated with a diallyl phthalate resin and bonded by heat and pressure to a veneered panel. The resin saturated sheet fuses with the wood veneer face for protection. Evaluated under NEMA standards, the panels meet or exceed standards for resistance to wear, scrubbing, boiling water, high temperatures, cigarette burns, and stains. Surfaces are unaffected by solvents, bleaches, nail polish, and dye. Thicknesses range from 9/16 inch to 1-3/16 inches; dimensions as large as 48 inches x 96 inches; in all available species of wood veneer except cypress and rosewood.

Small Scale Fire Tests Win Approval

So-called "small-scale" test methods to determine flame-spread characteristics for developmental and research purposes only were recognized by Committee E–5 on Fire Tests of Materials and Construction, during ASTM Committee Week in Chicago, February 1–5, 1960. The radiant panel test method is presently being considered by the Society as an approved method in Federal specifications. This method is not intended for use by building code authorities to establish ratings of materials. The smaller 8-ft. tunnel test developed at the U. S. Forest Products Laboratory, was also approved as a proposed method of test.

Changes were approved in the standard fire test method, E 119, a rating test. The changes relate to the conditioning of test specimens and the height of simulated attic space above ceiling assemblies. These revisions, if approved, will now be incorporated into the standard. The "tunnel test" for measuring flame-spread characteristics (E 84) was approved for advancement to standard subject to Society approval.



KVAL Scissor Lifts Announced

Kvalheim Machinery Co., Petaluma, Cal., has initiated manufacture of scissor lifts, used to raise materials to a convenient level for feeding and off bearing by actuation of a foot switch or automatic device. Lift shown uses 3- by 6-foot table which can be raised or lowered from 9 to 40 inches. Load capacity, 4,000 lbs.

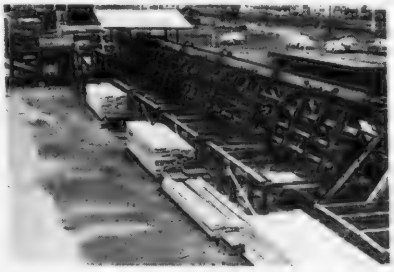
United Nations Magazine Publishes Mater Article

An article on "Automation in Medium and Small Sawmills" by Milton H. Mater, President of Mater Machine Works, Inc. and Senior Partner of Mater Engineering, in Corvallis, is one of the features of the March *Unasylva*, Official Publication of the United Nations Food and Agriculture Organization.

Published in Rome and printed in English, French and Spanish, *Unasylva* is prepared by the Forestry and Forest Products Division and covers authoritative articles in the forestry field. Mater, who is considered the international expert on sawmill automation, was asked to prepare the study by F. A. O. Directors. The article deals particularly with how automation can be applied to medium and small sawmills throughout the world. Mater has also been invited to be the official speaker on the subject of sawmill automation at the 5th World Forestry Congress this Fall.

Automatic Grademarker

Stetson–Ross Machine Co., Seattle 4, Wash., has issued a catalog sheet on its WT–100 Grademaker, which positions the end of the board on the chain corresponding to correct grade, and prints by means of electric eye. Takes stock 1 to 6 inches to any length.



Monarch Lumber Thickness Sorter

Monarch Forge & Machine Works, Portland, recently installed an AMSU sorter at Dorris Lumber Co., Dorris, Cal. Lumber is fed by a breakdown infeed chain from box cars and automatically measured and sorted in 1/32-inch increments. This unit

measures lumber thickness at speed of 400 foot per minute and automatically makes 9 sorts; in thickness ranges from 1 inch to 3 inches. The unit occupies space 150 feet long by 22 feet wide; handles boards to 18 feet long and 24 inches wide. Write: Monarch Forge, 2130 NW. York St., Portland 10, Ore.

Infrared Ovens Cut Drying Time From Hours to Minutes

Use of 14-ft. driQuik ceramic-type electric ovens recently installed at the Indiana Cabinet Company, Dubois, Indiana has cut drying time for parts of furniture from 2 hours to 8 minutes. The driQuik ovens, manufactured by the Dry Clime Lamp Corp., Greensbury, Ind., are part of two new conveyorized finishing lines. On the first finishing line, the furniture parts pass through a roller coater which applies the base coat, the parts are then carried on the conveyor for a three-minute flash-off period, through the infra-red oven for two minutes, and finish with a three-minute cooling off period. The second finishing line is practically a duplicate of the first.

New National Casein Adhesive

A new malamine glue that produces a completely waterproof bond for plywood and edge-glued lumber has been announced by National Casein Co. of Chicago and Riverton, N. J. Called "M–3", it is a white, practically-odorless powder containing no filters or catalyst. Hot press and high frequency gluing are recommended. Write National Casein, 601 W. 80th St., Chicago 20.

Pallet Industry Issues New Specifications

The National Wooden Pallet Mfg. Association has issued new specs, and grades for hardwood permanent or returnable pallets. The new specs, create for grades, known as Precision. Premium, "AA" and "A". More than $100,000,000 is spent annually for wooden pallets. The 20-page bulletin is available at 50¢ through NWPMA, 609 Barr Bldg., Washington 6, D. C.

Kiln-dried, pressure-creosoted Douglas-fir was used for the wood-stave pipe, which was 10'2" inside diameter.

The 6,050 foot pipe delivers water from Victoria Falls Dam to generators of the Upper Peninsula Power Co.

Treated Douglas-fir Used In 6,000 Foot Pipe Line

Rockland, Michigan—Wood-stave pipe recently was selected by the Upper Peninsula Power Company as the ideal solution to a major construction problem for a hydro-electric generating station.

Kiln-dried, pressure-creosoted Douglas Fir was chosen for the construction of a 10'2" inside diameter pipe, 6,050 feet long, to deliver water from the Victoria Falls Dam to the company's generator station for power development.

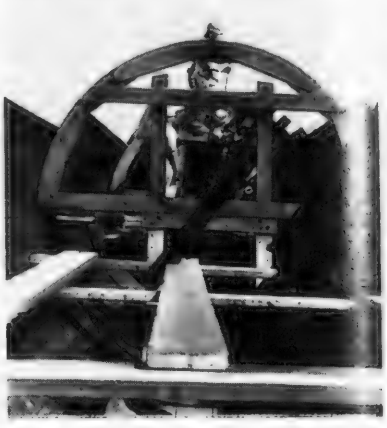
The pipe line was constructed by the Tank and Pipe Department of Simpson Engineered Wood Products Co., Portland, Oreg., a division of Simpson Timber Co.

Simpson had been called in to repair sections of the original untreated wood pipe line which needed repairs after 30 years of trouble-free service. Simpson worked around the clock to furnish 72,000 board feet of lumber needed to replace 336 feet of pipe. The break was repaired in 23 days. Later, Simpson replaced another 500 feet of the original line.

In view of such service, the power company decided to have Simpson completely reconstruct the pipeline of wood, this time using kiln-dried pressure-creosoted Douglas fir to provide an installation with a life expectancy of 50 years or longer.

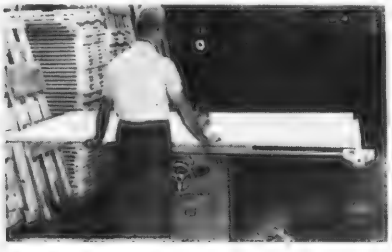
Workmen inspect the wood staves during construction.

The staves, 3–1/2 inches thick and 5–1/2 inches wide with 72 to the circle, were fabricated with a specially designed malleable iron casting between stave ends to insure water-tight joints. The continuous stave pipe is banded with round steel bands connected with malleable iron shoes.



Wood staves were 3 1/2 inches thick, 5 1/2 inches wide with 72 to the circle.

Three-quarters of a million board feet of lumber staves, used to rebuild the pipe line, were shipped from the factory knocked down, facilitating delivery to the building site. The job was erected by local contractors aided by the skilled technical assistance of the Simpson construction supervisor.



New Boice-Crane Monomaster Saws

Boice-Crane Co., 929 W. Central Ave., Toledo 6, Ohio has just added two new 10 inch tablesaws to their line of Monomaster saws. The fence-to-blade capacity of 49 inches is sufficient to spit 8-foot plywood panels crosswise without the need of extension tables. Three horsepower (H.P.) motors have been added to all models of the Monomaster and are also available on spindle shapers and 12 inch x 4 inch planers.

Westvaco Introduces Flakeboard Doors

At lumber dealer shows early this year, West Virginia Pulp and Paper Co., Building Boards Div., has exhibited a variety of new products made of paper—overlaid particle boards. A low-cost closet unit, complete with doors, can be easily assembled by one man. Folding and sliding doors are pre-packaged. Larger, 4 by 8 foot panels, are available in a variety of hardwood veneered surfaces.

Crossett to Build New Plant

A $6 million medium-density wood shavings board plant is being designed and constructed for the Crossett Lumber Co., Crossett, Ark., by Ford, Bacon & Davis Inc., New York, engineering firm.

The new plant, second of its kind in the U.S., will produce 100 tons of board daily by the Behr process, using gum wood. Technical consultant is Donald R. Seip Co.

Wood Trade Journals Merge

The Wood-Worker and *Veneers & Plywood* have been purchased by the Vance Publishing Corp. and will be merged into *Wood & Wood Products*, effective with the May issue.

According to J. F. Koellisch, editor and manager of *Wood & Wood Products* and a trustee of FPRS Midwest Section, *Veneers and Plywood* will be incorporated as a special section and the regular department features of *The Wood-Worker* will be continued in the new and larger publication.

What's New in *Technical Publications*

ngle Copies of the Following Reports a Available Free Upon Request from the D ctor, U.S. Forest Products Laboratory, M ison 5, Wis.

eport No. 2170, "The Effect of Environmental Factors on Wood Quality," is ne of four reports recently issued by th U.S. Forest Products Laboratory here. T new report describes the effects that sp ific environmental factors, such as cl ate and soil, have on the growth of tr s and explains how certain structural cl acteristics of the wood caused by gr wth conditions affect its quality.

A progress report entitled, "Comparison of Wood Preservatives in Mississippi Post Study," No. 1757, presents up-to-date information on the condition of treated posts at the Harrison Experimental Forest, Saucier, Mass., and describes the materials and treatments used in the study.

The other two reports, No. 200, "List of Publications on Mechanical Properties and Structural Uses of Wood and Wood Products," and No. 1081, "Partial List of Government Publications of Interest to Architects, Builders, Engineers, and Retail Lumbermen," are publication listings that were revised to include the latest source material.

RESEARCH POSITION

Adhesive Resin Chemist—Major adhesive company in Pacific Northwest requires chemist for research and development work in formulation and applications of adhesives and binders for wood products industries. Minimum of 4–5 years experience with phenolic and urea resins for these fields. Must be capable of working into direction of laboratory concentrating in them. Salary commensurate with training, experience and potential. Send resume, recent photo, salary requirements, date of availability in reply.

Send replies to:

E-392, Employment Service

FOREST PRODUCTS RESEARCH SOCIETY
417 North Walnut Street
Madison 5, Wisconsin

POSITION OFFERED

Engineer, preferably mechanical, wanted for responsible position in San Francisco research and development headquarters of major forest products manufacturer. Applicant should now be employed in the forest products industries. Send complete resume in reply.

Send replies to:

E-386, Employment Service

FOREST PRODUCTS RESEARCH SOCIETY
417 North Walnut Street
Madison 5, Wisconsin

NAMES in the NEWS

David R. Countryman has been named Manager of Research and Engineering for the Douglas Fir Plywood Association.

Daniel H. Brown, research engineer, took over Countryman's former post of Manager of Applied Research.

C. H. "Chris" Kreienbaum, 65, vice chairman of Simpson Timber Co., and a leader in West Coast forest products affairs for the past 4 decades, retired in March.

G. M. Curtis, president of Curtis Companies, Inc., Clinton, Iowa, is the new president of Ponderosa Pine Woodwork Assn.

W. E. Griffee, Portland, was officially named secretary-manager of the Western Pine Association to succeed S. V. Fullaway, Jr., retired.

Walter J. DeLong, Weyerhaeuser Company, was named 1960 chairman of the program and planning committee of the American Forest Products Industries.

The election of **G. E. Karlen,** Karlen-Davis Co., Tacoma, Wash., to the board of Directors of United States Plywood Corporation was announced recently.

ABITIBI
COMPOSITION BOARD
RESEARCH AND DEVELOPMENT

The Central Research Division of the Abitibi Power and Paper Company, Limited, which has particle board, insulation board and hardboard operations in the U. S. and Canada, is enlarging its Panelboard Department.

We have openings for University graduates in basic research, process development, new product development and application studies.

We invite applications from both new graduates and experienced men, who are interested in the expanding field of composition board and have initiative and an inquiring mind.

Salary dependent on qualifications.

Please send resume of education and experience to:

DR. RODGER M. DORLAND
Director of Research
Central Research Division
Abitibi Power & Paper Company, Limited
Sault Ste. Marie, Ontario, Canada

(Professional Card)

MATER ENGINEERING

Professional consulting engineers for the forest products industry.
Sawmill automation, design, modernization, integrated plants, complete technical and economic studies.

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CORVALLIS, OREGON
Phone Plaza 3-7335

EMPLOYMENT *Opportunities*

Inquiries concerning employment listings or ads to be placed in the JOURNAL should be addressed to FPRS Employment Service, P. O. Box 2010, University Station, Madison 5, Wis. Correspondence is kept confidential.

E–384—Technical director to be responsible for new Collins Pine Company flakeboard quality control and devolpment laboratory at Chester, California. Ability to formulate and administer quality control, process and product development programs necessary. Wood technology degree required and experience in flakeboard or particle board laboratory and/or production desired. (April)

E–385—Quality piano manufacturer located in New York City wants wood technologist to train as assistant superintendent. Shop experience in furniture or piano work desirable. Applicant should be familiar with gluing techniques, laminating, wood-working machinery, etc. (April)

E-389—Product Development. Leading redwood operation is expanding its product development section. Opportunity to work in development of mill applied coatings to lumber and plywood, waste utilization, plywood products, hardwood utilization glued products, etc. Prefer man with M.S. or B.S. in wood technology or wood utilization. (May)

Employment Wanted

595—University of Michigan wood technology graduate, holds degree of Forest-Engineer from European University. Presently holds supervisory position in wood working firm, seeks production, quality control, or managerial position in wood working industry. Age 33; married. (April)

598—Assistant manager plywood operation available June. Experience, training (MF) totals 18 years, incl. R & D, admin., sales, some production. Objective top management. Age 39. Resume on request. (April)

599—Production management in fields of plywood and particle board, and sales promotion in same fields. BS in forest products and management; Minor in Accounting. Six years' experience quality control and industrial engineering in plywood and veneer. Married. Located on West Coast. Would consider opportunity in Northeast or on the East Coast. (April)

600—Sales, promotion, or public relations position wanted by wood technologist with sales training. Experience in plywood, adhesives, technical services, quality control, R. & D.B.S. in Forest Products, University of Washington. Prefer West. Age 32, married, 3 children. Available May, 1960.

605—Young man, single. Will graduate from University of Michigan in June, 1960, with a major in Wood Technology. Second field, Forestry. Would accept employment anywhere, except in the general South. Interested in research, production, management, or sales—in that order.

135 NEW OR TRANSFER MEMBERS IN MARCH

Section Officers Please Take Note. We are going to publish each month all of the NEW or Transferred-into-the-Section Members. Please adjust your records, and gear to the most concerted New Membership Activity in FPRS history!

CAROLINA–CHESAPEAKE

Robert D. Brooks, R. Hoe & Co., Inc., High Point, N. C.
Sam W. Freeman, Drexel Furniture Co., Drexel, N. C.
Donald Gilbert, Route 4, Salisbury, Md.
Donald Mackey, P. O. Box 1726, Raleigh, North Carolina.

EASTERN CANADIAN

Rene Barry, 5, du Parloir St., P. O. Box 657, U.T., Quebec 4, Can.
Stan J. Byrne, 151 Caluington Drive, Downsview, Ontario, Can.
David J. Danbury, 343 Northumberland St., Fredericton, N. B., Can.
Albert A. De Mezey, Ap. 406, 4 Latimer Ave., Toronto, Ontario, Can.
General Hardwood Co., 2489 Bloor Street, West, Toronto 9, Ontario, Can.
Leslie Kertes, 155 King St., East, Toronto 1, Ontario, Can.
Richard Lacasse, 143 Ave. Parent, Quebec, P. Q., Can.
Walter A. Mahal, 9 Kinsdale Blvd., Toronto, Ontario, Can.
D. W. Milne, Milne, Laidlaw & Associate, Ltd., 50 Oak St., Toronto 15, Ontario, Can.
Charles A. Moore, 1550 Rand Ave., Vancouver 14, D. C., Can.
Emile Ouellet, 2605 Blvd. Laurier, Quebec 10, Quebec, Can.
William S. Pollock, 4700 Roslyn Ave., Montreal 29, Quebec, Can.
J. P. Rogers, Hay & Co., Ltd., Norwich Ave., Woodstock, Ontario, Can.
Walter S. Shisko, Donnacona Paper Co., Donnacona, P. Q., Can.

GREAT LAKES

R. H. Clapp, West Wayne St., Celina, O.
R. William Covert, 328 Second, Ann Arbor, Mich.
Daniel L. Den Houter, 506 Keech, Ann Arbor, Mich.
Jack C. Gerard, 21 Garden S. E., Grand Rapids, Mich.
A. J. Glass, 919 Wheeler Street, Saginaw, Mich.
Alain H. Granjon, 2037 Geddes, Ann Arbor, Mich.
Donald R. Hakala, 1445 University Terr., Ann Arbor, Mich.
Jessup Wood Products, Inc., Attn: Robert Jessup, Pres., Douagiac, Mich.
Walter H. Johnson, 400 Perrin, Apt. 7, Ypsilanti, Mich.
Robert W. Kenyon, P. O. Box 228, Charlevoix, Mich.
Albert D. Leins, S. E. Overton Co., Elkenburg, St., South Haven, Mich.
Duane Lyan, 254 Prescott House, E. Quadrangle, Ann Arbor, Mich.
Donald J. Mast, 6242 Dexter Rd., Dexter, Mich.
Max Maxey, Jessup Wood Products, Inc., 426 East Railroad, Dowagiac, Mich.
B. J. Meyer, Automatic Music, Inc., 1500 Union Ave. S. E., Grand Rapids 2, Mich.
K. M. Nanayya, 1330 Wilmot, Ann Arbor, Mich.
Myron L. Newton, V M Corp., Benton Harbor, Mich.
Stephen W. Peckham, 2108 Vinewood Blvd., Ann Arbor, Mich.
Robert R. Stevens, 3255 Central, Dexter, Mich.
Stanton G. Thomas, 1314 I. University Village, Michigan State University, East Lansing, Mich.
David E. Weiss, 719 W. Madison, Apt. 1, Ann Arbor, Mich.
D. E. Kralovec, North Main St., Fostoria, O.

INLAND EMPIRE

R. H. Houck, 9043rd St., Potlatch Forests, Inc., Lewiston, Idaho.
Lloyd L. Reesman, 521 Russell, Missoula, Mont.

MIDSOUTH

J. Alonzo Broom, P. O. Box 87, Magnolia, Ark.
Bailey Brown, Wilco Machine Works, Box 3722, Memphis, Tenn.
F. D. Buehl, P. O. Box 4891 No. Sta. Memphis, Tenn.
Robert Q. Conner, Crossett Paper Mills, Crossett, Ark.
William C. Cowan, Memphis Machinery & Supply Co., Inc., P. O. Box 225, Memphis 1, Tenn.
William B. Craig, 503 So. Second St. Box 2573, Memphis 2, Tenn.
Louis Furushiro, c/o Taylor Mfg. Co., P. O. Box 1069, Taylor, Tex.
Quintus H. Herron, P. O. Box 511, Idabel, Okla.
A. P. Jerome, 899 Madison Ave., Memphis, Tenn.
James H. Kaye, 129 Wren, Chapman Chemical Co., New Orleans 24, La.
Gilbert L. Kelly, 1101 Meadow Dr., Lake Charles, La.
Kenneth C. Larkey, 128 Main St., Memphis, Tenn.
Ellis S. Martin, Martin Timber, Co., Inc., Castor, La.
W. D. Morse, Jr., Crossett Lumber Co., 804 Elm St., Crossett, Ark.
J. Fred Miller, Box 550, Willis, Tex.
Claudette Smith, Russell Dry Kiln Co., Star City, Ark.
Wilborn Smith, P. O. Box 87, Magnolia, Ark.
James R. Spears, Russell Dry Koln, Co., P. O. Box 124, Fordcye, Ark.

MIDWEST

Syed Shah Noor Ali, 1207 University Ave., Columbia, Mo.
Charles A. Bartels, Hoosier Panel Co., 6126 N. Knox Ave., Chicago 46, Ill.
Marshall Nils Brunden, 698 Pammel Court, Ames, Iowa.
Erwin H. Bulgrin, 2038 Spruce St., Murphysboro, Ill.
Chain Belt Company, Attn: Robert T. Steindorf, P. O. Box 2022, Milwaukee 1, Wis.
Norman M. Dean, 1441 Rockingham Rd., Davenport, Iowa.
Robert C. Ginke, Dunphy Boat Corp., P. O. Box 738, Oshkosh, Wis.
Donald R. Haylett, Solem Machine Company, 6306 Alpine Road, Loves Park, Rockford, Ill.
Conrad D. Kohler, Vice–Pres., Kohler–Joa Corp., Sheboygan Falls, Wis.
Robert R. Maeglin, # 40 Meadow Lane Trailer Court, Ames, Iowa.
Richard J. Nordby, 5842 W. Addison St., Chicago 34, Ill.
William Roddis, 1010 E. 4th St., Marshfield, Wis.
Ronald W. Schaberg, 815 Virginia, Columbia, Missouri.
Bernard H. Shunk, 1324 N. Truman R., Independence, Mo.
Conley C. Stewart, Kroehler Mfg. Co., 5th Ave., Naperville, Ill.

NORTHEAST

Baumritter Corporation, Attn: Clinton W. Walker, Vice–Pres., 145 East 32nd St., New York, N. Y.
Albert J. Brouillette, 19 Vaine St., Winchendon, Mass.
David A. Groom, 1223 James St., Turtle Creek, Penn.
Richard F. Haussman, % U.S. F.S. 6816 Market St., Upper Darby, Penn.
William J. Jackson, 279 Bernhardt Dr., Amherst 26, N. Y.
C. C. Kuehn, 515 5th Avenue R. 2701, New York 17, N. Y.
Leon Kutik, 432 West 45th Street, New York 36, N. Y.
H. V. Lundy, Muncy Valley Industries, Inc., Muncy Valley, Penn.
Charles H. Martin, Det. #1. 12th Air Postal Sqdr., A.P.O. 30, New York, N. Y
Clare B. Mitchell, 11 School St., Orleans, Ver.
Robert A. Orkis, 204 3rd. St., Cementon, Penn.
George D. Pelton, Lewis Brothers, Inc., West Rupert, Ver.
J. A. Alexander Seldomridge, P. O. Box 857, State College, Penn.

EDITOR'S NOTE

The following errata were found in the November publication of **"Improvements Through Research on Thin Circular Saw Blades,"** by C. P. Berolzheimer and C. H. Best: p. 407, col. 3, line 18—dimension $1\frac{1}{16}$ should be $7\frac{1}{16}$ inch; p. 409, col. 2, line 1—"0.0001 inch this" should be "0.0001 inch thick"; p. 409, col. 2 line 26, dimension 0.60 should be 0.06; caption for Figure 6 should read ". . . No. 1, no flame, No. 2, flame." Corrected reprints, which also contain acknowledgements that were deleted by the *Journal* editor, are available in limited quantity from the authors.

Ralph W. Taylor, Jr., Jamestown Table Co., Jamestown, N. Y.
N. C. Wiley, Vice–Pres., Atkins & Merrill, Inc., Bartlett Street, Marlboro, Mass.

NORTHERN CALIFORNIA

D. Irving Cobb, 934 S. Main St., Willits, Calif.
Mal Coombs, Box 55, Coombs Lumber Co., Inc., Garberville, Calif.
MacGrefor Graham, 1952 Wright Ave., Richmond, Calif.
Peter H. Koehler, P. O. Box 502, [illegible]ent City, Calif.
William J. McCudden, 770 Filbert, [illegible]ico, California.
W. T. Wier, 3719 Grove Ave., Palo [illegible]lto, California.

OHIO VALLEY

Charles N. Border, 7th & Pestalozzi Sts [illegible]ell City, Ind.
D. E. Kralovec, N. Main St., Fostoria [illegible]p., Fostoria, O.
Lee Rodda, 333 West First St., Masonite [illegible]rp, Dayton 2, Ohio.
Harold F. Taylor, Chief Chemist, La[illegible]an Wood Finish Co. Inc., 1602 W. Was[illegible]ton St., P. O., Box 414, Indianapolis 6.

PACIFIC NORTHWEST

Paul A. Barber, 1639 Elm St., McM[illegible]lle, Ore.
Dr. Louis H. Bock, Rayonier Canada Ltd. Research Div., 8809 Heather St., Vancouver 14, B.C., Can.
Wm. W. Brinkley, P. O. Box 780, [illegible]ma 1, Wash.
William A. Buhler, 3548 . 23rd., Vanc[illegible]er, B.C., Can.
H. B. Carswell, Mgr. Dir., Spear & J[illegible]n B. C. & Ltd., 6700 Rumble St., S Bu[illegible]v, Vancouver, B C.
M. D. Chriss, Weyerhaeuser Company, [illegible]Natek Division, P. O. Box 1645, Tacoma 1, Wash.
Don W. Craig, 267 E. Newton, Seattl[illegible]2, Wash.
Paulis Cukrus, Box 62, Lehanon, Ore.
Dwight Dill, M.D., Texas Farms, Pembe[illegible]n, B. C., Can.
Paul R. Doe, P. O. Box 847, Medford, Ore.
Harold Erickson, 2460 So. 272nd St., Auburn, Wash.
Arthur E. Gruhl, 8317 South 35th St., Tacoma 66, Wash.
R. V. Harkema, 1100 Public Service Bldg., Portland, Ore.
F. W. Horstkotte & Associates, 523 American Bank Bldg., Portland 5, Ore.
Don MacDonald, Seattle Door Co., Kirkland, Wash.
John W. Mangan, 880 E. Grant St., Lebanon, Ore.
William T. Nearn, Weyerhauser Timber Co., Central Research Lab., Longview, Wash.
Herbert H. Nierman, % Scott Paper Co., Everett, Wash.
E. G. Putnam, 6520–16th Ave. N. E., Seattle 15, Wash.
John F. Ravenhill, 7630 Ash St., Vancouver 14, B. C., Can.
James R. Wells, Mill Equipment, Inc., 5219 First Ave. So., Seattle 8, Wash.
Thomas J. Welsh, P. O. Box 329 Panel Way, Longview, Wash.
Rodney K. Wilson, 9534 N. Polk, Portland 3, Ore.
W. H. Zuercher, Stetson-Ross Machine Co., Inc., 3200 First Ave. So., Seattle 4, Wash.

PACIFIC SOUTHWEST

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Robert D. Stevenson, 496 North Allen, Pasadena, Calif.

ROCKY MOUNTAIN

H. T. Hofer, 5525 E. 38th, Denver 7, C[illegible]
Richard A. Oberg, 209 W. Lake St., [illegible] Collins, Colo.

SOUTHEASTERN

Robert L. Langston, Auburn University, [illegible] 91, Jemison, Ala.
Robert D. Royal, Box 580, Newman, Ga.

UPPER MISSISSIPPI VALLEY

Lynn C. Adolphson, Archer-Daniels Midl[illegible] Co., Box 532, Minneapolis 40, Minn.
Leonard F. Burkart, 2119 'B' Hoyt Ave. W St. Paul 8, Minn.
Mary E. Durkee, Box 67, Durkee Manufacting Co., Inc., Pine River, Minn.
Lee R. Gjovik, 1515 Edmund Ave., St. Pa[illegible] 4, Minn.
George McNeice, 4500 S. Garfield Ave., Minneapolis 9, Minn.

Make this simple Glue Test...

Convince yourself that National Casein's FA-300 is the preferred gap-filling, non-craze urea resin glue for plastic top and hardboard-to-wood gluing

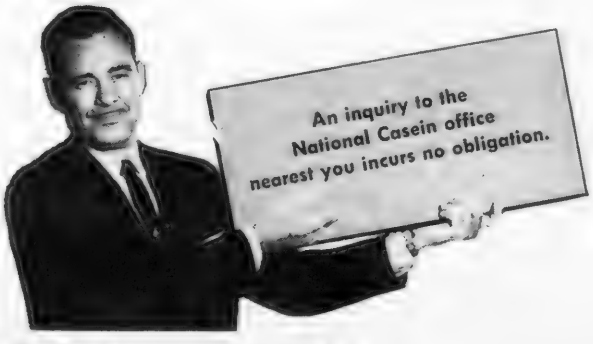
Take two Dixie cups. In one put a half measure of ordinary Urea Resin glue. In the other, a half measure of National Casein's FA-300.

After they have set, note how the ordinary Urea Resin becomes brittle and cracked, over a period of a couple of weeks, almost to the point of disintegration.

In contrast, note how National Casein's FA-300 retains its original form.

National Casein's FA-300 Modified Urea Resin is a non-craze, gap-filling glue ideally suited for plastic top gluing, hardboard to plywood gluing, and certain special plywood laminating jobs. It is widely used in top quality door manufacturing plants.

In high frequency gluing—where complicated clamping devices are used—where close tolerances are difficult to maintain—and for curved work—National Casein's FA-300 has proved to be the difference between a good job and a reject in many cases.



National Casein

New Supporting Member—Chain Belt Co.

Steindorf

Newest FPRS Supporting Member is the Chain Belt Co., Milwaukee, Wis., a pioneer in the field of mechanical power, transmission, and conveying and one of the world's largest manufacturers of chain and sprockets; bulk handling equipment; water, sewage, and waste treatment equipment; construction machinery and roller bearings.

Robert T. Steindorf, Director of Research and Development, has been designated to represent the Chain Belt Co. in Society activities. Mr. Steindorf, an engineering graduate of Purdue University, has been with Chain Belt since 1924. He was appointed Director of Research in 1959. For 11 years prior to that he served as manager of the conveyor and process equipment division.

Founded in 1891 in Milwaukee as a manufacturer of cast detachable chains primarily for the agricultural industry, Chain Belt now has modern, well-equipped plants in Milwaukee; West Milwaukee; Downers Grove and Dolton, Ill.; Los Angeles, Calif.; Madison, Ind.; Louisville, Ky.; and Springfield and Worcester, Mass. It maintains subsidiary companies in Canada, Switzerland, Italy, and Japan. Since 1891, the company's product line has grown from 1 to 66, and its net worth has increased from $12,000 to a reported $44.5 million in 1959, with sales of $66.4 million. From the simple chain of the first year, the chain line steadily expanded to include many types for the lumber, pulp and paper industry, rock products, construction fields, and other industries where chains for power transmission and conveying were demanded.

The next step was the addition of steel chains for construction equipment, oil field drilling rigs, and other heavy duty applications. This led to the development of belt conveyors, chain conveyors, feeders and bucket elevators for the handling of bulk materials.

The company has also developed chain-driven concrete and mixing equipment, and its construction machinery section is one of the largest manufacturers of construction equipment in the world.

Another important segment of Chain Belt activities is concerned with providing efficient methods of water and sewage treatment. Much of this processing equipment is widely used in pulp and paper mills. Bar screens remove solids from water to protect pumps; traveling water screens remove debris from large volumes of incoming process water; spray nozzles dislodge grit before it dulls the teeth of valuable saws or chipper blades; horizontal flow-settling tanks remove fibers and other materials from the effluent.

In almost all of the markets where the company's products are sold, there is a need for self-aligning roller bearings. Therefore, in 1953 Chain Belt acquired the assets of the Shafer Bearing Co. All Chain Belt products are manufactured under the trademark "Rex" with the exception of the bearings which are made under the "Shafer" trademark.

For more than 65 years Chain Belt has supplied the forest products industries equipment to move wood in any form along the processing routes.

In the sawmill, Rex chain provides power from the log haul to the barker; it moves and positions logs and feeds them to the saw carriage; it transfers lumber to edgers and trimmers, removes slabs and trimmings, and carries the lumber off to the green chains, sorting tables, and stackers.

To and from the kiln through the planing mill, the lumber is carried and processed on chains and roller chains. Chip plants and pulp mills are also mobilized by Rex chains and bulk conveyors that start at the log haul and carry straight through to the digester. Fiberboard, hardboard and plywood plants are mechanized and automated into smoothly functioning "flow-chart operations" on Chain Belt equipment.

FPRS welcomes the Chain Belt Co. to its growing list of Supporting Members and the Society looks forward to a long, continuing and mutually profitable association with an organization guided by the philosophy that "The shape of tomorrow is formed today."

WANTED

ADHESIVE PROBLEMS

Our Laboratories are anxious to work on adhesive problems others have failed to solve.

We have developed adhesives for

Plastic	Glass	Fibreglass
Fabric	Pliofilm	Plywood
Tinfoil	Brakes	Polythene
Leather	Metal	Cellophane
Rubber	Cork	Concrete

and many other materials.

Write us if you have an adhesive problem. Samples will be submitted without charge.

ADHESIVE PRODUCTS
CORPORATION
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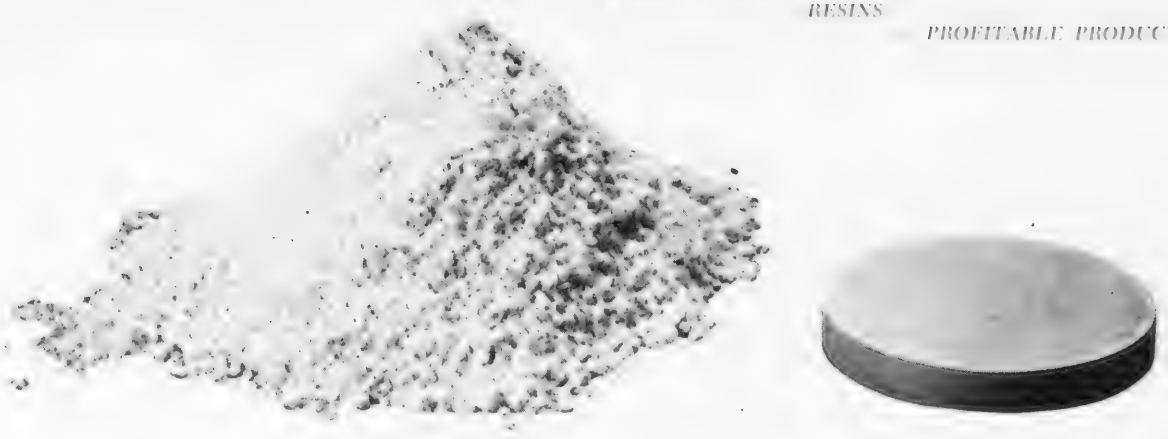

Fig. 2.—Bulk factor, left; volume necessary to mold disc, right.

FUNDAMENTALS OF Molding Wood Particles

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Sheboygan, Wis.

Molding a product from a mixture of wood particles and resin is a profitable way of utilizing wood residues, but certain variables, such as specific gravity, resin content, mesh size, molding pressure, and temperature, must be considered in relation to their influence on cure cycle, water absorption, impact strength, and screw-holding power.

FIRST, WHAT IS MEANT IN THIS DISCUSSION by molding wood particles? Perhaps it is best to begin with a definition. Generally speaking, we are referring to molding or shaping a mixture of wood particles and synthetic binder into useful products. This process is often given other names, such as the molding of sawdust, granulated wood, wood waste or wood chips.

For the scope of this discussion, we will be dealing with physical mixtures of wood particles (in the mesh range of 20 to 140) and powdered phenolic resin. In this operation, the wood particles and resin are mixed together in a dry process. Liquids are not normally involved. A physical mixture will contain resin in the range of 10 to 35 percent by weight; the balance of the mixture is granulated wood or other additives. After the physical blending operation, the mixture is pressed in a metal mold under pressures of 500 to 1500 psi. The temperature of the metal molds is in the range of 300° to 375° F.

Basically then, this is what we mean by molding wood particles for the purpose of this discussion: the molding of a physical mixture of wood particles and synthetic binder under heat and pressure to produce a useful product. Other questions that will be considered are: why this type of material should be used; what type of operations could use this process; what type of products can be made by this process; how this process differs from the use of other types of molding compounds; what properties can be expected from this molded mixture; and how the various process variables affect these properties.

Why Mold?

First, why should we consider the use of this type of material? This method offers a means of using a low-cost product to make useful articles. In many cases, these wood particles would otherwise be wasted or used for less economical purposes such as fuel. For several products, the use of molded wood particles has produced higher quality with respect to certain properties, and at a lower cost than was possible with the same product machined from solid wood.

The manufacturers who have the most interest in this type of fabricating probably fall into three groups:

1. A millwork, furniture, or other woodwork manufacturer who has a considerable amount of wood waste to dispose of. The molding operation would be particularly attractive if the molded pieces could be used with their present products in some manner.
2. A manufacturer of an article from solid wood who could make the same article of higher quality or at lower cost by molding granulated wood. This type of operation can be economically feasible with purchased wood flour or sawdust.

The Author: Ken Brockschmidt holds a BS in chemical engineering from Washington University, St. Louis, Mo. His work at PEC includes development and sales of phenolic resins for the bonding of wood particles and other industrial uses.

A contributed paper received Jan. 1960.

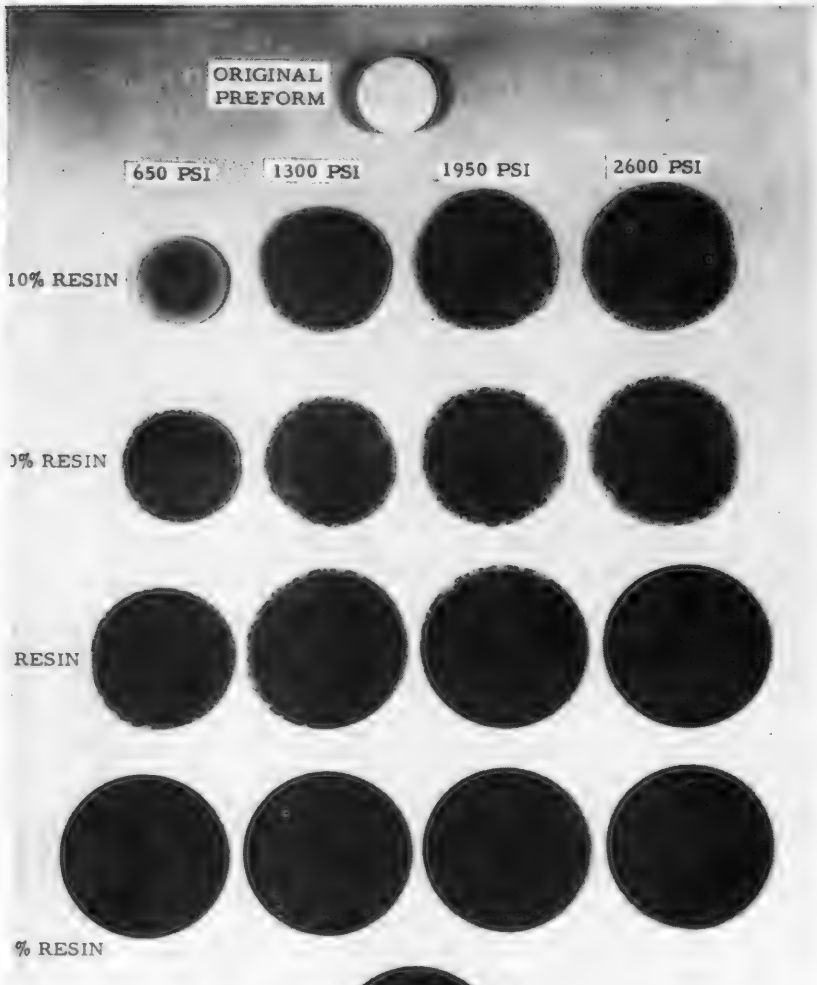


Fig. 3—A comparative test to illustrate the flow of mixtures with varying resin contents molded under varying pressures. The 2-inch preform at the top was placed in a 4-inch die to produce the various flow characteristics illustrated. (See tabulation p. 181)

3. A molder of plastic materials who has press equipment available to make a product of a wood-resin mixture that could increase the versatility of his operation.

What Products?

One product that immediately comes to mind is a particle board. Since many papers have been published concerning the manufacture and properties of particle boards, we will not discuss this product. We are more concerned with products that have some shape. These shaped articles will be made from a mixture having a finer wood particle and a higher resin content than most particle board mixtures, and the molded article will also generally be of a higher density than the normal particle board range.

In considering a product to be made from a wood particle-resin mixture, several factors should be considered. A product of a rather simple shape should be chosen since the mixture does not have the ability to flow into intricate mold shapes, especially in the lower resin contents. Flat sections or curves with generous radii are best suited. A discussion of the flow characteristics of these mixtures will follow. The product chosen should be one that can be produced in volume sufficient to pay for the cost of the metal mold, molding press, mixer, and auxiliary equipment.

One natural place to look for products to make of a wood-resin mixture is those products that are now presently made from wood. If a number of machining and finishing operations are involved in producing a product from solid wood, the molding of this product could offer considerable economy by replacing all of these operations with the one operation of molding. Also, in molding a product, practically all of the material going into the mold will appear in the finished product. This eliminates the waste that would be encountered in cutting, planing, sanding, and other operations with solid wood. Improved properties can often be obtained by molding the product.

Another type of product to consider is one that is presently being molded of some type of plastic material. In some cases, a molding of a wood-resin mixture may be more economically suited for the application.

Examples of some of the items now being made from wood resin mixtures are shown on the cover. These products include toilet seats, hamper tops, brush backs, appliance bases, chair backs and seats, stool tops, bowls, croquet balls, croquet mallet tips, shuffleboard discs, wire spool flanges, pulleys, caster wheels, handles, and shoe heels.

Bulk Factor

A factor to consider in this type of molding is the bulk of the mixture. This mixture has a low density; therefore, it occupies a large volume for its weight. This fact has to be taken into consideration in designing a mold. Figure 2 shows the volume of mixture necessary to mold a disc 4 inches in diameter and ½ inch thick at 1.0 specific gravity. This ratio of the volume of powder needed to make a molded piece of given volume is known as the bulk factor. Bulk factor is defined as:

	Apparent Density grams/c.c.	Bulk Factor*
Ponderosa Pine	on 80 mesh—.220	4.55
	on 140 mesh—.204	4.90
	Thru 140 mesh—.166	6.0
Maple	on 80 mesh—.271	3.7
	on 140 mesh—.260	3.85
	Thru 140 mesh—.216	4.6

*The bulk factor given here then is the cubic inches of resin-wood flour mixture necessary to mold one cubic inch of a finished article at 1.0 specific gravity.

We might consider here also the difference between the general purpose phenolic molding compound (wood filled) and the physical blend of resin and wood particles. The compound generally contains a much higher percentage of resin than physical blend mixtures and a finer wood particle. The compound mixture is further processed after blending by putting the blended material on a heated roll. The rolling operation melts the resin to insure a better coverage of the wood fibers. The heat and pressure of rolling also advances the resin so that it will cure faster in the final compound. In addition, the moisture content of the

Fig. 4.—A cup 5 inches high with a 3-inch top diameter molded with vary[illegible] does increase the flow and improve appear[illegible]

wood is reduced, and the mixture is densified to reduce the bulk factor. Bulk factor of a molding compound will be 2.3 to produce a piece with a specific gravity of 1.38. This reduction in bulk factor produces a considerable difference in the molding equipment necessary. The design of the mold and the opening of press, commonly called "daylight", are both influenced by bulk factor.

Molding compounds are generally molded to their maximum density (1.38 specific gravity for general purpose compounds), while wood particle-resin mixtures are molded to a controlled density by the use of stops on the press or mold.

Flow Characteristics

Another factor to consider in molding this type of material is the flow. Flow is the ability of the material to move under pressure and/or heat to fill out the intricate parts of the mold. Mixtures with low resin content will have very little flow; therefore the shapes that can be formed with these mixtures are limited. To arrive at some comparison of mixtures with different resin contents and molded under different pressures, the following test was devised. A preform (wood flour-resin mixture pressed together under pressure only) 51 millimeters in diameter was placed in the center of a 102 millimeter die (4 inches) and molded. The pressure, of course, will first crush the preform and then the material will flow. The amount of flow was determined by measuring the diameter of the disc formed. As can be seen in Figure 3, the amount of flow measured with the low resin content material is very slight. Increased pressure does help promote flow, but only to a limited degree. The relationship of resin content, molding pressure, and the resulting flow is shown in the following table as well as being illustrated in Figure 3:

Resin (%)	Pressure on Mold (p.s.i.)	Distance of Flow (mm.)
10	650	56.5
10	1300	64
10	1950	70
10	2600	77
20	650	72.5
20	1300	83.5
20	1950	90
20	2600	95
35	650	90
35	1300	97.5
35	1950	100
35	2600	102 (Maximum)
50	650	102
50	1300	102
50	1950	102
50	2600	102
General Purpose Phenolic Molding Compound	650	102

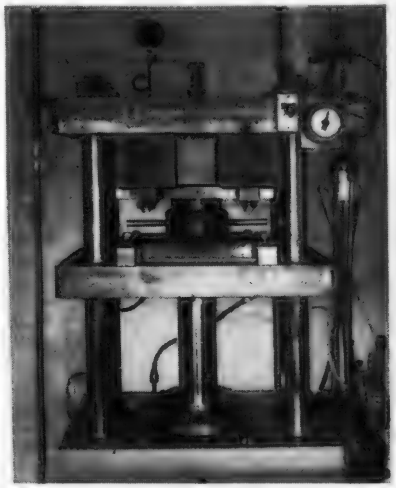


Fig. 5.—Hydraulic press used to mold the [illegible] is shown in the press.

Although this is only a comparative test, it does give some illustration of the flow characteristics of these materials.

Another method of showing the difference in flow with varying resin contents is shown in Figure 4. A cup with a top diameter of 3 inches, five inches high, was molded with mixtures of varying resin contents. With the 10 per cent resin mixture no flow was noted, and the cup did not begin to fill out. As the resin percentage was increased, the flow was noticeably better. The cup did fill out at 20 per cent, but the appearance was poor, with a noticeable lack of resin in the top portion of the cup. Appearance improves considerably with increases of resin content. Again a comparative test, but it does show that the resin content has to be considered in attempting to mold a piece of any complex nature.

[illegible] includes cavity, bottom punch, top [illegible] bars is also sh[illegible]

Other Variables

The molding of wood particles involves a number of variables that influence the properties of the finished molded article. Among the variables that can be controlled to influence the final properties are the mesh size of the wood, resin content, density of the molded article, molding pressure, and molding temperature.

The effect these variables have on such properties as cure cycle, water absorption, impact strength, and screw holding power, was tested under laboratory conditions. In order to test these variations, test discs were molded under the same conditions to check the influence of changing one variable. The data presented in Figures 7, 8, 9, 11, 12, 14, and 16 were based on the following conditions, unless otherwise specified in the graph or table shown:

Resin—Powdered phenolic (270 mesh plus)

Resin content—12% by weight of the total resin-wood mixture.

Wood—100 mesh Ponderosa Pine (Moisture content 5%)

Specimen size—4 inch diameter disc, ½ inch thick

Specific gravity—1.0 controlled by a stop on the mold and the weight of the material put into the mold.

Die temperature—310° F.

Molding pressure—2600 p.s.i. on the mold. This is not the actual pressure on the molded piece, since the press closes against a ring on the mold. This ring controls the thickness of the molded piece. With the thickness controlled, the specific gravity of the disc is controlled by the amount of material added to the mold.

Figure 5 illustrates the press used to mold the specimen discs used in these experiments. The four-piece mold shown in the press is the mold used for the 4-inch diameter discs. Figure 6 shows this mold disassembled with a sample of the molded specimen. The four parts of the mold are the cavity, bottom punch, top punch, and thickness control ring. With this ring in use, the thickness and, therefore, the volume are always constant, so the amount of material added to the mold will control the specific gravity.

The first series of variables tested was the effect of die temperature, specific gravity and resin content on the cure cycle of the molded disc. The cure time was taken as the minimum time required to produce a molded disc without blisters, blows, or bulges.

The variable that produced the most change in cure cycle was the specific gravity, as shown by Figure 7. The denser discs take longer, since there is more material to heat and gas release is more difficult. Another variable that also showed an effect on the cure time was the die temperature. This relationship is shown in Figure 8. The higher the die temperature the faster the cycle that could be obtained. Resin content of the molded disc in the range tested had very little effect on the cure cycle. Figure 9 shows this relationship. In estimating the time necessary for curing a molded item, these factors will have to be taken into consideration. The thickness of the molded item, of course, will also have a considerable influence on the molding cycle.

Water Absorption

Another property of interest to molders of wood particle mixtures is the water absorption. The effect of variables on this property was tested by molding specimen discs and then immersing these discs in a 77° F. water bath for 24 hours. Figure 10 is a view of the immersion tank used for these tests. The increase in weight of the specimen in 24 hours was obtained,

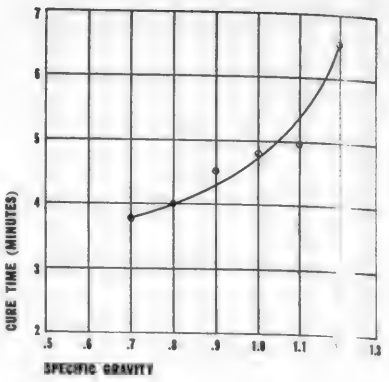


Fig. 7.—Relationship between specific gravity of a molded disc and the cure cycle. The ½-inch thick, 4-inch diameter disc, contained 12 percent resin and 88 percent 100 mesh softwood. Die temperature was 310° F.

and the percentage of increase in weight was reported on the graphs shown in Figures 11 and 12. Figure 11 shows the effect of increasing the specific gravity on the water absorption. The denser the molded disc the less the water absorption rate. Increasing the resin content has the effect of decreasing the water absorption as shown in Figure 12. This would be expected, since one of the functions of the resin is to protect the wood fiber, and the greater the quantity of resin used, the better this property should be.

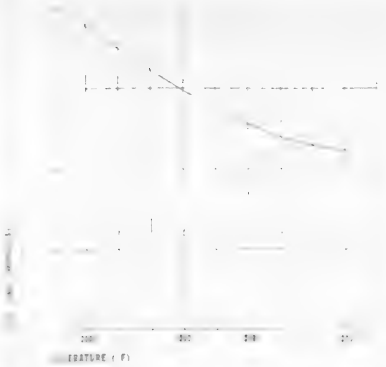
Screw-Holding Power

Screw-holding power is another property to consider in molding wood particle mixtures. The effect of variables on the screw-holding power was determined by turning a No. 6—¾ inch round head wood screw into a drilled 7/64 inch hole. The screw is then pulled out by a Dillon Dynamometer. Figure 13 illustrates the jig

Fig. 10.—Tank used for testing water absorption. Discs were held for 24 hours in water thermostatically controlled at 77° F.

Fig. 13.—Apparatus used to test screw-holding power. A 4-inch disc is held in the jig and force is applied to remove screw.

Fig. 15.—Equipment used to test impact strength.



F... 8.—Relationship between die temperatur and cure cycle. The ½-inch thick, 4-inch diameter disc contained 12 percent resin and 88 percent 100 mesh softwood. Specific gravity was 1.0.

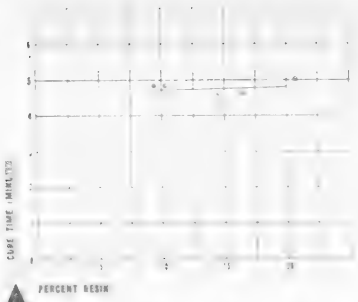


Fig. 9.—Relationship between resin content and cure cycle indicates the actual curing of the resin is not the controlling factor in the cure time.

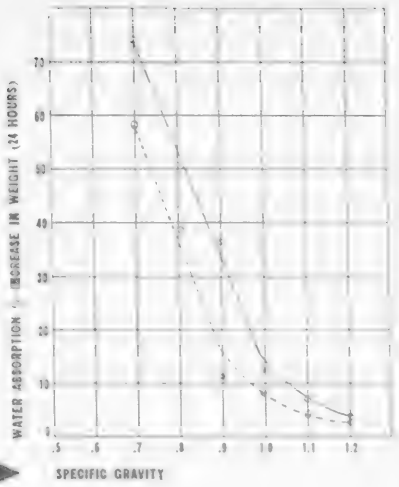


Fig. 11.—The improved resin (dashed line) shows better water-absorption properties. Both discs contained 88 percent 100 mesh wood flour and 12 percent resin.

holding the specimen in the dynamometer used to pull out the screws. Figure 14 shows the effect that increasing the specific gravity has on the screw holding power with two different mesh sizes of wood. The specific gravity of the molded piece was the important variable controlling the screw-holding power.

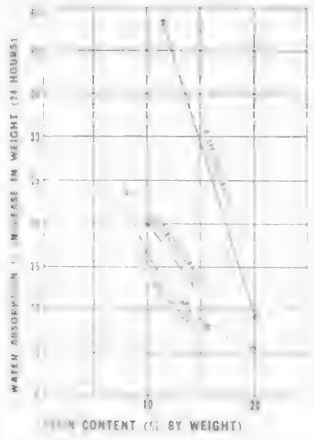


Fig. 12.—An increase in resin content improves water-absorption properties: dashed line is 100 mesh; solid line shows 80 mesh.

Impact Strength

Impact strength is another property to consider in molding a wood particle mixture. The specimens used for testing this were molded to the size used in ASTM standards for evaluating conventional phenolic molding compounds. The specimen bars were molded to a given specific gravity, again controlled by the amount of material added to the die shown in Figure 6. The specimens were cut and notched according to ASTM (Izod) standards. The machine used to test the impact strength is shown in Figure 15. This test measures the magnitude of the ability of the molded mixture to withstand a blow or impact. The force required to break the specimen is recorded in foot-pounds of energy per inch of notch. Figure 16 shows the effect of varying the specific gravity on the impact strength of the specimen.

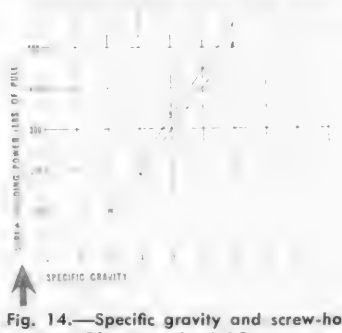


Fig. 14.—Specific gravity and screw-holding power. Discs contained 15 percent resin and 85 percent wood. Solid line is 80 mesh; dash is 40.

Fig. 16.—Relationship between specific gravity and impact strength. Legend: ——— 20 percent resin and 80 percent of 40 mesh wood flour; - - - - - - 12 percent resin and 88 percent of 100 mesh wood flour; . . . . . 20 percent resin and 80 percent of 100 mesh wood flour; -.-.-.-.-. 16 percent resin and 84 percent of 20 mesh wood flour.

Summary

The process of molding wood particles has then been defined as the shaping of a mixture of 20 to 140 mesh wood particles and synthetic binder into a useful article in a metal mold under heat and pressure. The resin content is in the range of 10 to 35 per cent, the molding temperature 300° to 375° F., the pressure 500 to 1500 psi.

A mixture of this type lacks flow (the ability to fill out an intricate mold) and has a high bulk factor. Products made by this process include toilet seats, chair backs, croquet balls, shuffleboard discs, etc.

Process variables such as specific gravity, resin content, mesh size of the wood, molding pressure, molding temperature, are discussed with relationship to their influence on the cure cycle, water absorption, impact strength, and screw-holding power. To produce the best mixture for any given application will require considering these properties and variables, and probably others, and then considering testing to obtain the needed mixture, cycle, and properties.

Peeler Procurement in California

RALPH ANDREE
United States Plywood Corporation
Redding, California

Efficient handling of peelers starts with premarking in the stand, supervised log marking, intelligent sorting at loading points, inventory control, and careful pond or sprinklered-deck storage.

With the introduction of effective sprinklering, the familiar log pond may soon be old fashioned: 40 acres of pond are used mostly for temporary storage as logs are moved from [illegible]

THE EFFICIENT MOVEMENT OF peelers from the standing tree to the pond or deck requires careful attention along the entire route. Because the handling and storage problems involved are distinctly western in flavor, some background might be needed to indicate the procedures followed and the overall size of the operation.

If we take 1959 as typical, we find that the Shasta Operation, south of Redding, California, had a total log consumption of roughly 95 million feet, 75 million of which were processed as sawlogs, while 20 million were peeled. In addition to supplying our own peelers and sawlogs, Shasta produced about 7 million feet of Douglas-fir peelers of the sheathing type and about 7 million feet of Incense cedar for other operations.

The Author: Ralph Andree, a University of California graduate, is a forester at U.S. Plywood's Shasta Plywood Division.

The total volume of logs handled was divided among 10 logging contractors, who ran a total of 11 sides, the largest of which cut about 22 million feet and the smallest about 2 million feet for the season. Practically all sides had to sort logs in the woods at one time or another during the season. Even those sides that did not produce peelers were faced with sorting cedar from the other species.

Five species were handled: ponderosa pine, sugar pine, Douglas-fir, white fir and Incense cedar. Talking strictly about peeler specifications, the following conditions prevail as regards log size:

Species	Min. DIB Inches	Min. DBH Inches
PP	20	26
SP	20	26
DF	14	20
WF	24	30

These minimum DIB figures are for core grade peelers. Peeler logs are produced in the following lengths: 17, 26, 34 and 42 feet plus trim allowance. The smallest trees cut are those 20 inches DBH east of the Sacramento River and 22 inches DBH west of the Sacramento River, except for occasional knockdowns and damaged trees.

So much for background. The subject at hand has to do with peelers. Requirements for the year are established by the plant management in advance for the various species, and logging shows are set up accordingly by the timber department to meet these requirements. The decision to cut a given species on a given show as all sawlogs or to produce peelers and sawlogs depends on a number of factors, among which the most important are:

1. How badly a particular specie is needed as a peeler supply for the year.
2. The comparative quality of the specie in the particular show under consideration.
3. The volume of that specie that show in proportion to the total volume on the piece.

[1] Presented at Session VII, Logging, I 13th National Meeting, June 30, 1959, Francisco, California.

A curtain of protective mist covers the ends of freshly cut logs exposed to the thirsty rays of the California sun. Decked logs ready for hungry knives and saws include 30 million board feet for the sawmills and 9 million board feet of peelers.

4. Logging conditions and the size of operation contemplated.

It must be kept in mind that the total log supply for any year will come from several sources:

1. Long-term contract lands from which a given annual volume must be cut.
2. Company owned timber.
3. Forest Service, State or Bureau of Land Management sales which may or may not be bid during the year.
4. Small private purchases to be cut during the year.
5. Log trades. Different contract provisions for the purchase of timber, different logging situations, various scales on which the logs are purchased, and the various combinations of peelers utilization by show make thorough supervision of logging a must.

This supervision or pre-planning generally starts at Shasta with pre-marking of peelers in the standing tree. Our marking crew systematically covers the area to be logged by a given operator and marks the length of peelable logs to be bucked from each tree to be felled. For example, on the lands cut on our cutting contract administered by Shasta Forests Co., the Shafco markers use white paint to indicate which trees in the stand are to be cut. Close on their heels come the United States Plywood crew using yellow paint to designate peelers to be cut from that tree. A 34–34 means two 34–foot peelers will be bucked, and a 26–34 means that the butt cut will be a 26-foot log, the second cut a 34-foot log, and the rest of the tree bucked into sawlog lengths. These marks or appropriate others are put on each tree in the stand to be cut, and this is basically the system which has been used at Shasta for the last 10 years. With a well-trained crew of peeler markers, it works very well with a moderate amount of follow-up to be sure that trees are bucked as marked, and that each log has the proper amount of trim to satisfy the timber owner and the purchaser within acceptable limits.

This procedure does not always prove the most satisfactory. For example, in denser stands of tall timber with heavy undergrowth, and where longer than usual lengths of peelers are being cut, it is quite difficult to pinpoint exact lengths within a few feet at a point five or six 16-foot logs above the stump. To be certain that the maximum length goes into peelers on Douglas-fir, for example, we embarked on an intensive program of faller education—to train fallers and buckers to buck the appropriate peeler lengths without pre-marking in the standing tree. This type of peeler selection requires more intensive supervision than pre-marking, but it seems to be working very well. In stands of coast-type Douglas-fir, the latter procedure is followed extensively on company operations, but the problem is much simpler in that most of the timber is a single species, and any length peeler can be produced in the woods. Fallers and buckers are trained to utilize a tree to a given knot size, and peelers are separated from sawlogs at the landing by one man—called a peeler picker.

So much for peeler production at the marking and bucking stage. The

Sprinkler system helps logs retain moisture, reduces end checking, lowers costly trim.

This blue-stained board is now a rarity at Shasta since log decks were sprinklered in 1955.

Four miles of pipe and 500 fog zels carry a constant spray to every log ck.

Giant log loader heads for plywood plant. King-sized peelers are undamaged by long months of deck storage.

next important step in getting a properly bucked peeler to our plant is at the log-loading point or landing. On medium and large volume shows (80 M per day and up), the log scaler performs a dual function of scaling logs and aiding the loader in selecting peelers. Responsibility for proper sorting rests with the top loader or jammer operator. Over a dozen different types of mixed or homogeneous loads are possible if all five species are involved.

Single loads of sawlogs or peelers are preferred, of course, but this is not always possible. Here are a few examples of acceptable mixed loads:

1. Ponderosa pine peelers on the bunk with cedar on top.
2. Mixed species of sawlogs on the bunk with either ponderosa pine or sugar pine and white fir peelers on top.
3. Sugar pine and white fir peelers on the bunk with ponderosa pine peelers on top. The scaler notes on the scale ticket for each load —in addition to net scale, defect and other customary items—what kind of logs are being shipped. This is re-checked at the log delivery point to be certain that accurate records are kept of log inventory by species and grade.

Log unloading at the Shasta operation is done in one of three ways:

1. Dumped over the brow log into the pond.
2. Picked off by a log stacker and put into a deck.
3. Picked off with a shovel and put into a deck or the pond.

Here the reason for sorting becomes apparent: sugar pine and white fir peelers are decked and sprinkled constantly, ponderosa pine peelers are stored loose in the pond, sawlogs of all species are either dumped in the pond or decked and sprinkled. The peeler dump, sawlog dump, and cedar dump are on the same property, but separated by 0.4 mile. Two ponds are used: one of 19 acres for the plywood plant, and another of 21 acres for the sawmill. These ponds have a total capacity of 8 MM feet of peelers and 4 MM feet of loose sawlogs. In addition to pond storage, the Shasta operation relies on decking of both peelers and sawlogs. All sugar pine and white fir peelers are decked and sprinkled to avoid an excessive amount of sinkers had they been dumped in the pond. Decks are built up by a 25-ton log stacker to a height of about 15 feet, and as soon as the deck is at least one pipe length long, the sprinkling system is put into action.

The sprinkling system consi of pumps, pipe, rainbirds and og nozzles. Water from the pond fil- tered through a 60 foot horizon in- take enclosed by a rock fill. The ake has 3/8 inch perforations on ch centers, and serves a deep well r a centrifugal pump. Six inch alum um irrigation pipe is used on the d ks, reducing to 2 inches at the far e of the decks. Fog nozzles are placed on the deck edges every 20 feet with rainbirds down the center of two adjacent decks every 30 feet to give complete coverage. The system for all decks includes 8 pumps, about 4 miles of pipe, and over 500 fog nozzles and rainbirds.

Indicative of the size of this decking operation are the following figures for the period of maximum decked volume in 1959:

Total sawlog volume in decks	29,000 M
Total peeler volume in decks	6,000 M
Total decked volume	35,000 M

The peak volume of logs handled daily runs over 600 M in 12 hours.

To sum up, the efficient movement of peelers from the standing tree to the pond or deck at United States Plywood's Shasta Operation depends on special attention to the following key points:

1. Pre-marking in the timber and close supervision of g marking.
2. Log sorting at the loading po t
3. Log dumping and inventory trol at destination.
4. Sprinklering of decked logs a 24 hour basis.

The most important factor, unm tioned until now, is the human fa r of cultivating an inventive attitude solve the inevitable problems that ar

Small Log Harvesting

The source has barely been tapped, and the potential is astounding, but problems needing attention include new logging methods for small logs, stand access, market analysis, and an understanding by forest owners of small-log potential.

W. A. DAVIES
School of Forestry, Oregon State College

Thinning can double forest yield by harvesting the natural mortality. Here, a small tractor skids salvage and thinning logs.

SMALL-LOG LOGGING in the Douglas-fir region of the Northwest is in a relatively new, experimental stage. Prejudices and traditions make progress in this field slow, but some loggers and wood processors are beginning to realize the possibilities of utilizing Douglas-fir logs under 16 inches in diameter.

Sources and Potential

Small logs are becoming increasingly important as a source of raw material for the wood industries of the Douglas-fir region. At present the bulk of these logs comes from normal logging operations with some small trees in the stand, and from premature clear-cutting in second-growth stands. Other sources include salvage, pre-logging and thinning. Volume from salvage is decreasing, and the potential is not great due to increased utilization in the original logging. Pre-logging is becoming popular in old-growth stands with understories of small trees. Removing the small trees prior to clear-cutting serves two purposes: (1) there is less loss in breakage, and (2) the final logging, which is geared to handling large material, is more efficient when there are fewer small logs to handle. However, the extra volume derived from pre-logging is not great, because most of this volume would be removed with the normal logging. Last, but by no means least, is the source of small logs from thinning young Douglas-fir stands. Here we have barely scratched the surface, and the potential is astounding.

The Douglas-fir region is in a revoluntionary transition from wild forests to managed forests. As this change progresses, there will be more and more dependence on small logs, and many of them will come from thinnings. The present generation has grown up on large old-growth logs and finds it difficult to think in other terms. The change, however, is inevitable. Only the public agencies and a very few large companies hold old-growth reserves for more than a few years of cutting.

As timber lands are converted to second-growth, good management dictates that an increasing volume be obtained by thinning the young stands. Douglas-fir is intolerant of shade and grows best in even-aged stands. Silviculturists agree that clear-cutting is the best harvesting practice, and that 80 to 100 years is a logical rotation age. During this rotation age, however, a large quantity of wood is lost, if it is not removed periodically. Nature is very wasteful and never in a hurry. A newly established stand may contain several thousand tress per acre, but when the stand is 90 or 100 years old, it may consist of 100 or fewer trees per acre. During its life, a stand will lose the majority of the original trees by competition, insects, disease, snow, and wind.

Man can salvage a large part of this loss by periodic thinnings, and the volumes obtainable are astounding. Thinning is an important and established part of timber harvesting in Europe. The Danes, who have been growing Douglas-fir for many years, have found that the volume from thinning is about equal to the volume at final harvest. They are doubling the yield from the land by harvesting the natural mortality. Silviculturists have stated that an average of 600 board feet per acre per year could be thinned from Douglas-fir stands

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[1] Presented at Session VII, Logging, FPRS 13th National Meeting, June 30, 1959, San Francisco, California.

This 85-year old stand of Douglas-fir has been thinned twice. Second thinning yielded 6,000 board feet per acre.

This 90-year old stand of Douglas-fir could yield about 7,000 board feet per acre in salvage thinnings.

through a 100-year rotation. This volume multiplied by the 30 million acres of commercial forest land in the region is equal to 18 billion board feet, or one and one-half times the present total annual cut in the region. Of course this is a theoretical potential for some time in the distant future. At present, the approximately 8 million acres of young stands of commercial thinning size in the region have a potential annual yield of over 4 billion board feet from thinnings. Probably not more than 50 million board feet and certainly not more than 100 million board feet per year, are now being produced from thinnings.

Volume from thinnings is non-depletable. Properly done, thinning is a stand improvement measure. The final harvest volume will be at least as great as in an unthinned stand, and the quality and tree size will be greater. This is one instance where a timber owner can have his cake and eat it too. It would be good practice to thin even if no profit were made—if the stumpage value came out to zero. However, the stumpage value of thinnings can be high where the stand is accessible and near a market. Recently a public agency put a salvage thinning up for bid and realized $28 per 1000 board feet.

Many owners of young timber don't appreciate the possibilities in thinning and salvage. State and county extension foresters are doing a good job of educating the small owners, and as owners become aware of the values involved there should be a rapid increase in the volume of wood from this source.

Logging Problems

Logging small logs in the Douglas fir region is in a groping, experimental stage, but things are moving fast. The methods used are essentially the same as those used in old-growth logging, but with smaller equipment. One company pioneered commercial thinning with horse logging, because it was thought that any other method would do considerable damage to the remaining stand. Later this company switched to small tractors, and found that if the loggers have the proper attitude little damage is done. Recently, cable systems have been used to a limited extent in conjunction with horses and tractors, and have been satisfactory with careful loggers. Steel towers mounted on trucks have been developed for thinning and salvage on the steeper areas. Many other types of equipment have been used, including home-made donkeys mounted on trucks, rubber-tired tractors, and even farm-type tractors. However, the basic systems are the same as those used for many years in the normal clear-cut logging.

The variety of loading equipment used to load small logs is as great as the variety of yarding equipment. Most of the conventional systems, with smaller equipment, are employed. Some operators are loading one small log at a time with tongs or end hooks. Others are using grapples and fork lifts and can load several logs at once.

The cost of logging on a board-foot, log-scale basis obviously is greater for small logs than for large. There is a mixture of sizes and the logging must be geared to handle large logs. If the costs are converted to a cubic-foot basis, the cost differential between large and small logs is not as great.

Here are some figures on small thinning operations in Douglas-fir in the Willamette Valley of Oregon. The areas were similar in size (between 30 and 40 acres) and from 5 to 7 thousand board feet per acre were removed from each. Following is a tabulation of the costs on these three areas plus the costs on an area that was clear-cut after an earlier thinning some years before.

Area	Average Log	Cost per M bd. ft. Scribner Rule
No. 1	50 bd. ft.	$3
No. 2	82 bd. ft.	$2
No. 3	100 bd. ft.	$2
Clearcut	345 bd. ft.	$1

The above costs include truck hauls of 12 to 15 miles. All areas were tractor logged, and no road development cost was involved.

It can be seen from these figures that log size affects the logging cost when the unit of measure is the board foot, Scribner rule. When the costs were converted to a cubic-foot basis, it was found that they were similar for each area. This shows that the logging cost per cubic foot of wood can be about the same for small logs as for larger logs. As long as the board foot Scribner Rule is the unit of measurement for logs, the small-log logger must handle more wood, and therefore more weight, per board foot than the large-log logger. Perhaps the unit of measurement will be changed in the future. Cubic feet and weight have been used to some extent. One large company, which contracts much of its small-log logging, pays the logger on a weight basis. Each load is weighed and the contracts call for a price per ton.

Another obstacle to logging small logs, especially thinnings, is lack of access. Much of the young timber of thinning size is far from a road or on very steep ground. Timber owners are reluctant to incur large development costs that cannot be amortized by the first cut. Thinning on steep ground is very difficult with the present methods, and new ideas and new developments in equipment and methods are needed.

Forklift tractors can load several small logs at a time or single logs containing up to 1,000 board feet.

Crown spacing in an 80-year old Douglas-fir stand after thinning.

In fact, new developments are needed in all phases of small-log logging. As previously stated, small logs are handled primarily by the same methods as used for large logs. We loggers in the region have been slow to adopt new methods developed and proven in other regions and in other countries. Tradition ties us down. Certain things have become standard and it is difficult to think in any other terms. Perhaps someone with imagination and who knows nothing about logging or our traditions is best qualified to develop new ways of handlding small logs.

One tradition is the use of a choker, a short cable attached to a log in the yarding process. Loggers claim that the cost of logging small logs is high because it costs as much to put a choker around a small log as around a large one. If this be true, perhaps chokers should not be used; some type of mechanical hand or grapple would be more efficient.

Many new ideas have been discussed. The most glamorous one is probably the use of helicopters. As yet this has not been proven practicable. Rubber-tired tractors will probably replace many of the crawler type. Skylines are used extensively in Europe to transport small logs, and more use will probably be made here of skylines and other cable systems, especially on the steeper slopes. Certainly, many new ideas, some as yet unheard of, will be developed as the old-growth forests are replaced by thrifty young stands.

Market Problems

The availability of markets controls the production of small logs, and at present the outlets in the region are not adequate. Most of the small logs are sawn in mills designed for large logs. It is not efficient to put a 6-inch log on a large carriage and run it through a head rig designed for 60 inch logs. Some scrag mills and small gang mills are in operation, but most of them are units of larger mills. They are used to keep the small logs away from the main mill, and the owners are not anxious to purchase additional small logs.

The pulp market is not good at present. Prices paid for small logs are low due to the availability of other cheap wood such as chips. Pulp chips may be purchased at the saw mill for the equivalent of $15 per 1000 board feet. As long as this condition exists, the volume of small logs used for pulp will remain low.

The use of small logs for veneer is increasing. Some 4- and 8-foot lathes have been installed to peel the better small logs. Usually only logs more than 14 inches in diameter are used, which leaves the smaller logs for other types of utilization.

Small logs may be used for poles, but this is not a large market. Only a few of the trees cut in a thinning operation are adequate for poles. Therefore it appears that the greatest potential use for logs from 6 to 15 inches in diameter is for lumber, with the leftovers being used for pulp.

The value of small logs for lumber production is high if manufactured in an efficient plant. On a log-scale basis (Scribner Rule) the pond value may be higher for small logs than for large logs. This is due to a higher overrun from the small logs. A study made by the Forest Products Research Center in Corvallis, Oregon, shows that the overrun from logs 6 to 16 inches in diameter is about 50 percent. The overrun from larger logs cut in conventional saw mills is usually between 10 and 20 percent. Even with a lower average lumber value and a slightly higher milling cost, the small logs may have a higher pond value on a log-scale basis.

In some cases, where efficient small mills are operating, this higher value has been reflected in the log price. One company in Western Oregon, which operates a very efficient gang mill, paid $55 to $60 per 1000 board feet for small logs down to 6 inches in diameter during 1958. Lumber prices were not particularly good last year, but this company showed a profit. A neighboring larger mill paid a slightly lower price for larger logs and showed a loss for the year.

Saw mills designed to cut large logs are no longer considered to be efficient unless integrated with other uses. The owner of a large saw mill must either give up the mill or expand to other uses to get greater value from the logs. This is not true of small mills designed to cut small logs. It appears that the operation of one of these small mills, with the leftovers being chipped for pulp, is about the only way to get into the lumber manufacturing business in a small way at the present time. In the future there will probably be numerous efficient, small mills specifically designed to cut small logs only. They will be supplied by salvage to some extent, but chiefly by thinnings from small woodlots, from tree farms, and from the public forests.

Summary

As stands in the Douglas-fir region are changed from wild forests to managed forests, small logs will become more important as raw material. Presently small logs are coming from the normal logging operations, prematurely cut second-growth stands, salvage, pre-logging and a limited amount of thinning. The greatest potential source is from thinnings. Small-log logging is in a groping, experimental stage, and new ideas and developments are needed. An important obstacle to small log production is lack of markets. Lumber appears to be the most logical utilization, and mills particularly designed to cut small logs are needed.

Four logs scaling 24,500 feet were recovered from an old spar tree left in a Washington swamp when it was logged about 20 years ago.

Salvage Logging Pays Dividends

JOHN MILES
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Salvaging logs, snags, windfalls, chunks, and low-grade logs must stand on its own economic merits, but it holds collateral benefits—reduces fire hazard, opens roads for brush control, seeding, and planting. In short, puts the area back in timber production, often at a profit.

IT IS ALWAYS HELPFUL TO VIEW current problems in historical perspective. The historical approach furnishes analogies by means of which we can better comprehend the whole field of salvage logging. It permits us to examine at leisure the conditions from which the need for it have sprung, and it gives us the benefit of hindsight in selecting the necessary remedies for our time. The term "salvage logging" appears to be a fairly recent invention of the language, used to dignify acts that are necessary to repair old mistakes; but the reading of history proves that the mistakes, or the problems, are not new.

We may liken the term "salvage logging" to Sir Walter Raleigh's cloak for example. We may further liken Sir Walter to the logging industry, the Queen to the wood-using industries, and the people of London of that time to our own end-products consumers. As you know, Sir Walter laid down his cloak so that Queen could get over a particularly bothersome puddle that stood between her and the people of London. Now, it may very well be that Sir Walter was responsible for the puddle being there in the first place. It may also be that the responsibility was the Queen's . . . after all, she owned the outfit, and even if Walter was the direct cause he was working for her at the time. It is also possible that the people of London, growing tired of the quality of water they got, all turned their taps off at once and put a serious strain on the municipal utilities. Or it may just have been an early rain. No matter, really; whatever the cause, the puddle was there. Sir Walter come up with a cloak, and the matter was satisfactorily resoved.

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Residues—The Logging Puddle

So it is in our time. The puddle today represents what is left of potential value after the prime logging has first gone through the woods and removed the obviously usable and high-value parts of the timber stand. This residue may be left because of poor market; or because of manufacturing facilities or techniques inadequate to utilize fully the lower grades, smaller sizes, and so-called inferior species of wood; or because of adverse logging conditions; or, sometimes, because of the habits that have become ingrained in the logging industry.

Let me point out here that this is no derogation of the logger. There is a considerable time lapse between the drawing up of the logging plan, the construction of roads, the felling and bucking of the timber, and the final logging. Operations may have to be moved, or suspended for days or months because of inclement weather. With the necessity for continuous production heavy upon him, the logger must concentrate on the part of his resource that gives him the highest production at the least possible cost right now. If the market improves and a lower grade and smaller size of log becomes saleable, he rarely finds it practical to back track.

Economic Problems

It very often is poor business to spend a great deal of money falling and bucking and possibly even decking the marginal logs as he goes along, for even a slight decline in the market will make it impossible for him to recover these costs. And because of the time lapse, the logger is usually forced to guess at what will be the lower limits of profitability weeks or months ahead. Little wonder, then, that the prime logging has left behind something of value; the wonder is that it has not left more.

[1] Presented at Session VII, Logging, FPRS 13th National Meeting, June 30, 1959, San Francisco, Calif.

Logged in 1933, burned and reburned, this Washington forest was relogged in 1955, scarified and seeded in 1956.

Logs and chunks from redwood, fir, and hemlock residues in Humboldt County, California. Logs ranged from 8 to 120 inches in diameter, 8 to 40 feet in length. Area had been clearcut in 1939.

Now, what is the effect of what we might call normal or historical logging practices on the wood supply? Usually the prime logging yields the full volume of wood that the cruiser stated was on the area, and that the timber owner bought and paid for. The reason is that cruising practices and timber transactions have recognized the difficulty of evaluating the residue, or the puddle, so it has been omitted from the inventory. So far as the individual operation, or the industry as a whole, is concerned, everything has been used that was bargained for. The fact that considerable wood has been wasted and considerable values still remain, usually has not affected the profitability of the operation, provided the timber was not foolishly high-graded.

The residue, or the puddle, then represents an addition to the stated inventory, or an over-run of the cruise. Provided, of course, that new markets or better manufacturing facilities or new logging techniques can be found to make it worth going back after. Relogging must stand on its own economic merits. If it can be done profitably, the volume of recoverable wood can reasonably be added to the inventory both for that operation and for the country as a whole.

Management Benefits

There may be, and there usually are, collateral benefits to be gained through relogging by any company attempting to manage land and grow timber. Older logging areas are usually bad fire hazards, because of the great volumes of fuel and numbers of snags that contribute to the spread, the intensity, and the difficulty of control of fires. The slash has been burned, accidentally or purposely—and in the West, usually to comply with the law on most of the older cutovers. This has served usually to reduce the amount of fuels present, but the growth of annual weeds, ferns, and inflammable brush has resulted in renewal of the hazard over a period of years. These slash fires have all too often destroyed the initial coniferous reproduction, very often after the adjacent seed sources have been removed by logging. As a consequence, the older cutovers are frequently characterized by high fire hazards, heavy stands of brush and weed species, and a shortage of conifer reproduction.

Such areas, however, frequently carry considerable volumes of salvageable wood. This may consist of sound snags, old windfalls, chunks, and low-grade or high-defect logs left behind in logging. Assuming against that the market is there, this material can be logged at a profit; and in the course of logging, the snags get felled, the volume of fuel on the ground is reduced, the truck and tractor roads are opened up so that the area is accessible for fire fighting, brush control, and seeding or planting. The relogging operation, in short, makes it possible to put the area back into timber production, and quite possibly will return enough profit from the logging to more than pay the costs of rehabilitation.

Current Cutovers

So much for the older cutovers. With respect to the more recent ones, on which we will assume there is a stand of reproduction and a considerably higher valume of salvageable wood, the problem is not much different. The first question to be resolved is whether the value of the wood to be recovered now is greater than the possible damage to the reproduction. Since it is possible to completely replant an acre for $20 to $40, it obviously does not require that much wood be taken off to pay for complete destruction of all the seedlings. As a matter of fact, it is the general experience that a reasonably well conducted salvage operation using tractors, will disturb only about 25 to 30 percent of the actual ground surface, and in young reproduction (5–10 years of age) will reduce the stocking by somewhat *less* than 25 percent. If the initial stand was well stocked to begin with, the crowns of the remaining trees will make good use of the room above the skidroads and the final yield will be reduced by only a fraction of this percentage.

On current logging operations, where relogging follows prime logging by only a year or two, and where some viable seed may be left on the ground or may blow in from adjacent seed sources, relogging will actually improve the degree of stocking by making available more mineral soil for a seedbed. In the hemlock stands of Washington and Oregon, where high-lead logging is the rule and the reproduction is already well established before logging, enough of this advance reproduction survives the logging to give goodstocking. Relogging by high-lead to remove the pulpwood does not reduce it much.

In the redwood areas of California, where timber is marked for cutting by the selection system, relogging following close on the heels of the prime logger does not disturb the stump sprouts, and it increases the amount of mineral soil exposed for the seed produced by the residual old-growth trees.

In short, it is difficult to conceive of a situation wherein reasonably intelligent relogging will not actually improve the possibilities for artificial rehabilitation of older cutovers, and enable the quick establishment of natural stands of seedings on recent cutovers.

Clearcut in 1939, seed trees killed in a slash fire, this Humboldt County, California area was a fire hazard until relogging cleaned it up at a profit and prepared the ground for seeding.

Clearcut in 1945 and burned twice since, this area produced 8-foot redwood slab being loaded on top of redwood, white fir, Douglas-fir logs from blowdowns and cull trees.

Profitable "Puddle" Logging

Now, what are the tools and the techniques necessary for a good job of relogging? They are essentially the same as those necessary for a good job of prime logging. Closer attention must be paid to log manufacture, and, since high production in falling and bucking is impossible, it is usually more practical to pay cutters on an hourly rate rather than by the bushel.

The entire logging crew, cutting, yarding and loading, must be carefully trained, closely supervised, and impressed with the necessity for recognizing merchantability in a log. Since it is important that the relogging job be completed in one operation, and the ground then left undisturbed to go about producing the next crop, the logging job must be clean. Otherwise, there will be the temptation a few years later to go back after the next lowest fraction, but the salvage recovery is less likely to offset the loss in the ultimate yield of the second-growth.

Beyond that, the requirements for profitable relogging are the same as for profitable logging—machinery in good repair, experienced loggers, and production-minded supervision.

It happens very often that the relogging program is initiated by the forestry department, or it is set up more or less independent of the prime logging department. This may be because the logging department is already fully occupied in getting out the regular log supply, or because management thinks the foresters need the experience, or because someone has the idea that the people who left the wood behind in the first place are not likely to be enthusiastic about going back over old ground to pick up the scraps. Two other very good reasons apply. One, the ground or the residual old-growth stand must be left in first class silvicultural condition for the next cutting cycle. Two, getting the forestry department into the logging business gives the forester a crew and machinery of his own with which to do the land management job of fire road development, scarification for seeding or planting, snag-falling, and steam-bed clearance.

Whatever the reasons, there is a general inclination to separate the logging and relogging functions. So long as there remains a backlog of older cutovers to be cleaned up, or so long as there remains some doubt as to merchantibility standards and the continuance of markets for relog material, this makes good operating sense.

Laying the Cloak

However—and this constitutes a prophecy—if the markets are available for the products of relogging, then they are available for the same material produced by prime logging. This being true, the prime logging department should do the complete job of logging from here on out. Relogging, or salvage logging, will then be a temporary phenomenon, the cloak over the puddle as it were, the patching up of past mistakes than can be blamed on nobody or everybody; and the justification and the opportunity for it will have passed.

In closing, let me make these points:

1. Salvage logging, or relogging as a separate operation, is only a temporary necessity from an operating point of view.

2. Where it can be carried on profitably it facilitates the job of rehabilitating older cutovers and of putting recent or current cutovers into quick full production of the next crop.

3. It can underwrite much or all of the high costs of rehabilitating and fireproofing the older cutovers—these costs should be borne by the i[n] logging on current operations.

4. It should be concluded as ra[pidly] as possible, and the relogging po[rtion] of the harvest job merged with prime logging so that there exists one logging department, which c[om]pletes the whole harvest job on a g[iven] area in the least possible time, in s[uch] a way as to use all of the current [yield] of wood and speed the growing of next crop.

5. Whether we call it salvage ging, or relogging, or simply comp[lete] utilization in the prime logging job, this type of operation depends upon the existence of adequate manufacturing facilities and techniques, and a solid market for their products.

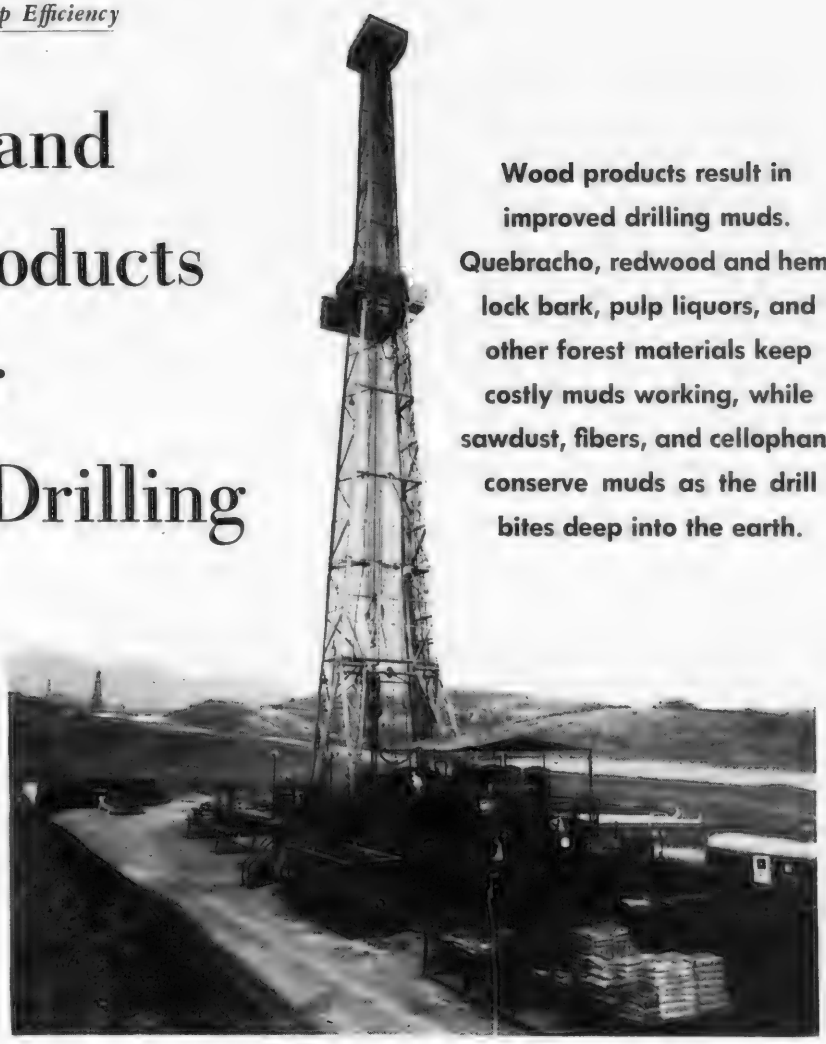
6. Any competent forester can describe and measure for you the volume of additional wood that will be available from such an operation, and any competent logger can get it to the mill. It is up to you, the products people, to find the uses and establish the markets for it. Do this for us, and we will find you more old wood, and grow you more new wood, than you ever thought possible.

Redwood chunks split from cull logs Del Norte County, California, will be s[awn] into high-grade lumber in the semiporta[ble] mill in background.

Keeping Drilling Fluids at Top Efficiency

Bark and Fiber Products for Oil Well Drilling

Wood products result in improved drilling muds. Quebracho, redwood and hemlock bark, pulp liquors, and other forest materials keep costly muds working, while sawdust, fibers, and cellophane conserve muds as the drill bites deep into the earth.



R. W. Miller and W. G. Van Beckum
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THE DRILLING OF A MODERN OIL well is a complex operation involving a considerable investment in time, manpower, and money even before the actual hole is started. Once the drilling is under way, the costs continue as a function of a number of variables, not the least of which is the drilling fluid or drilling mud, which usually contains silva-chemicals or other forest-industry derived products applicable to drilling fluid control.

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Drilling the Well

There may be those of you to whom the principles of oil well drilling are not familiar. Essentially, we have a hollow rotary drill bit attached to a hollow drill rod. The bit, of course, will cut a hole larger than the rod. The drill rods are threaded at the ends so that additional sections of rod may be added as the bit advances to greater depths. The drilling fluid is introduced into the hollow end of the drill stem at the surface through a flexible hose and a rotary joint. Thus, as the drill stem is rotated, driving the rotary bit, drilling fluid can be pumped down the hollow drill stem and returned to the surface in the annular space between the drill stem and the wall of the larger diameter hole. The working end of the drill bit is equipped with holes that permit the drilling fluid to be forced out with a jet or scouring action. This allows the rock cuttings to be flushed away from the working face into the annular space above the bit where they may be carried to the surface by the moving column of drilling fluid. At the surface, the drilling fluid is screened to remove the rock cuttings and returned to the hole by the pump.

[1] Presented at Session V, Chemical Utilization, FPRS 13th National Meeting June 29, 1959, San Francisco, Calif.

Functions of Fluids

The first purpose of circulating fluid in rotary drilling was to bring the cuttings from the bottom of the hole to the surface. Currently, the drilling fluid has many other functions. Among the more important are:

1. To lubricate and cool the bit and drill stem.
2. To coat the wall of the hole with a mud cake that will prevent loss of water from the fluid into the formation.
3. To aid in the control of subsurface pressures due to fluids

existing under pressure in the strata being traversed.

4. To maintain cuttings and weighting materials in suspension when the drilling fluid circulation is halted temporarily.
5. To aid in supporting the weight of the drill stem and well casing.
6. To minimize any adverse effects on the formation adjacent to the hole.
7. To provide a medium of the proper viscosity and density to bring the cuttings to the surface at the fluid-flow velocity prevailing in the annulus.

Drilling Mud Additives

The ability of the drilling mud to permit the accomplishment of any or all of these items is a function of the chemical and physical properties of the mud. The mud engineer servicing the well must be able to control these properties through adjustments or additions to the mud as determined by certain prescribed tests. For purposes of control, the mud engineer has at his disposal a variety of chemical additives, among which are the bark- or woodderived materials in which we are interested.

During the years, various types of drilling fluids have been developed to fit certain drilling conditions. Perhaps the best known of these are fresh water, calciumtreated, and emulsion muds. Actually, water alone was probably the first rotary drilling fluid, with no importance being attached to the solids that became suspended in the water as the drilling progressed. These first wells were shallow and when the mud became thick, water was added to lower the viscosity. Soon it was observed that certain formations produced better muds. Then drillers began adding non-gritty clay solids to the water to make similar muds. This was the beginning of mud control and the first muds were of the fresh water type.

As drilling progressed to other areas and deeper holes, high pressure zones were encountered and blow-outs and gushers were quite common. Experience soon showed that if more clay and/or inert weighting materials such as barytes, were loaded into the drilling fluids, the increased hydrostatic heads would balance or exceed subsurface pressures and blow-outs would be minimized. But along with the increased loading came prohibitive viscosities and gel strengths. Something was needed to keep the solids in the drilling fluid high, but still give a viscosity which would not interfere with circulation.

Quebracho—First Silva-Chemical

The next decade or so following the introduction of loading materials found considerable attention being given to the composition of the mud. It was soon discovered that the complex phosphates such as tetrasodium pyrophosphate, sodium acid-pyrophosphate and the hexametaphosphate, could be added to the high weight drilling fluids to lower the viscosity. Also, it was found that additions of quebracho extract aided in the viscosity reduction and further reduced filter loss by increasing dispersion of the colloidal clays. This was the first use of a silva-chemical in drilling fluids.

Barks and Wood Extracts

Throughout the years, quebracho has continued to be used as a drilling fluid additive. However, its price and availability has fluctuated with the fortunes and politics of Argentina, which is the principal producer. As a result of these uncertainties, various other materials were sought as replacements. Because of their tannin-like constituents, spent sulphite liquors from the chemical pulping of wood were investigated and found to perform as well or better than quebracho and at less cost. Subsequently, the barks of certain west coast trees, such as redwood, Douglas-fir, and hemlock, were found to yield similar or better deflocculants than did the pulping liquors. Any or all of the bark and wood extracts are currently used as additives to the drilling fluids for control of viscosity, gel strength and water loss. Some perform better than others as a function of the type of mud, geology of the strata, and not the least important, the know-how of the mud engineer servicing the well.

Performance of Organic Additives

There are several factors which enter into the performance of the organic additives as deflocculants in the drilling fluid systems. Among the more important are the attractive or repellant forces existing between particles due to ionization of the components and contaminants, electric charges developing on particle faces due to fracturing, adsorption, and absorption, and finally the degree of hydration of the solid phase material.

Clays are made in great part of thin plates or sheets. In water suspension and under the influence of hydration and agitation, the plates are broken into minute particles. This fracturing or separating of particles leaves residual electrical forces on the broken faces. The tendency is for these electrical forces to satisfy themselves through reagglomeration of the particles and their attractive force becomes particularly effective when agitation of the mass ceases. That is, when a clay suspension is permitted to remain quiescent for a period of time, the clay particles tend to arrange themselves into a definite pattern or gel structure as dictated by the charged particles and the spatial arrangements available. Such a structure may be broken down again by the energy of agitation and this tendency to thicken on standing and return to a fluid state under the action of agitation is called thixotropy.

The primary effect of the viscosity-reducing additives is to control the degree of thixotropy through shielding or altering the space relationships existing between the sheared particles without materially affecting that portion of the apparent viscosity due to hydration of the clay minerals. The additives are adsorbed on the active clay particle faces and satisfy the so-called broken-bond valences. The result is that the balance of forces is changed from one of attraction to one of repulsion or, at least, one of very weak action.

What Makes a Good Additi

A good additive for the control of viscosity and get strength should be readily soluble in the liquid phase over the entire pH range likely to be encountered. Moreover, the dispersant should not alter the formation conditions materially and should not be adversely affected by contaminants such as gypsum, clay, or salt water encountered during drilling. Color is of no importance. Stability to temperature becomes important in deep drilling or under other conditions where high temperatures are encountered.

From the standpoint of convenience, the material should be non-toxic, non-hygroscopic and be contained in easily handled packages for efficient use and storage at the well sites. Most of the organic additives offered to the industry today meet the requirements to some degree. A few of them are particularly well suited to performing in the presence of contaminants.

The recognized silva-chemicals of most interest to us for use in the drilling fluids are as follows:

1. Orzans—Crown Zellerbach Corporation.
2. Rayflo—Rayonier, Incorporated
3. Kembreak and Marasperse—Marathon Corporation.
4. Q-Broxin—Puget Sound Pulp and Timber Company.
5. Palcotan—The Pacific Lumber Company.
6. Quebracho extract.
7. Mangrove extract.
8. Eucalyptus extract.

)ther products may be considered as allied with the silva-chemicals mentioned, even though they may be only cellulosic or lignitic in structure or of extractive origin. These materials are such as sodium carboxymethylcellulose, humic acid types such as lignite, and the extracts of various foreign trees, such as mangrove and eucalyptus. Starches and gums are also used under some conditions.

Barks Extracts Do Two Jobs

The prime function of the wood and bark extracts is to control viscosity and gel strength. In the case of the starches, sodium carboxymethylcellulose and other hydrophyllic colloids, the main action is to lower water loss. Some of the bark extracts have the exceptional property of providing water loss control as well as the viscosity and gel strength control. Thus, they offer possibilities of great savings since the effective water loss control agents such as sodium carboxymethylcellulose are relatively expensive.

The action of the water-loss control agents in reducing fluidloss from the drilling fluid to the formation is one of protective colloid action. Essentially, the agent hydrates or gelantinizes to give a hydrophyllic film which coats the clay particles and fills the interstitial spaces in the mud cake coating the wall of the drill hole. The net result is a water trapping or holding which gives a material reduction in the loss of the liquid phase of the drilling fluid to the formation.

Fluid-loss control agents must be effective in small concentration, must be stable under well conditions, must be economical and readily available, must be non-corrosive, and should have no adverse affect on the other properties of the drilling fluids.

Fiber Additives

Finally, we come to the fibers which, although not silva-chemicals, are wood or bark derived. They are extremely useful in correcting the problem of lost circulation.

Loss of circulation during the drilling of an oil well occurs when porous or cavernous strata are encountered. The surface indication of this type of strata is the reduction or loss of mud return to the surface. What is happening when this occurs is that the drilling fluid is leaking away into the strata.

Bark Fibers Most Effective

Since drilling cannot proceed long under these conditions, corrective measures must be taken quickly. Fibrous materials may be added directly to the mud and circulated by or placed at the loss zone in an attempt to bridge and plug the leaks. Although many materials have been used for this purpose depending on cost, availability and the expediency of the situation, it has been found that wood- or bark-derived materials are usually most effective. In very serve cases, the loss area may have to be cemented and redrilled to eliminate the loss. The fibrous materials are also useful in cementing and for the same reasons.

Mud service engineer tests oil-well drilling fluid treated with Palcotan, a sulfonated extract of redwood bark.

The most important wood- or bark-derived items for lost circulation control are as follows:

1. Bark fibers such as Palco Seal produced by The Pacific Lumber Company from redwood bark.
2. Wood fibers such as Silvacel produced by Weyerhaeuser Timber Company from Douglas fir wood chips.
3. Hammermilled wood.
4. Wood sawdust.
5. Shredded cellophane (allied items).

Although most anything from chicken feathers to hog bristles may be introduced into an oil well in an effort to restore mud circulation, experience has shown that a fibrous-type material such as that produced from redwood bark or wood chips is most effective in bridging fissures and providing a matting against which the drilling mud can build up a wall cake and form an effective seal. Sometimes a combination of long fibered material such as the shredded redwood bark fiber with a shorter length material is more effective than either alone. Sawdust is usually used only when large supplies are available from nearby saw milling operations at very low cost. Cellophane shreds are used only in special cases due to their greater cost. There is no indication that their overall performance is any better than that for the fibrous materials.

Cooperative Research

To date, the two functions of chemical control and lost circulation correction provide essentially the entire market for tree-derived product in oil well drilling fluids. The forest products industries together with the petroleum and drilling fluid service industries have spent many thousands of research dollars to develop the products currently in use. Substantial research sums will undoubtedly go into further improvement of today's products to broaden their utility in the future.

The success enjoyed by forest products as extremely useful materials in oil well drilling comes about primarily because of the excellent cooperation displayed by the petroleum, drilling and forest products industries over the years in working together on a common research effort. All industry can well take a page from this record and profit from the research techniques used here in the further development of useful, marketable products.

Pickers empty the apples directly into the pallet bins, which hold the equivalent of about 25 standard boxes.

Filled bins are moved to trucks by forklift tractors. This 16-[illegible] load holds about 370 boxes of fruit.

HARVESTING APPLES WITH...

Pallet Bins in the Pacific Northwest[1]

S. W. McBirney
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In the first two years of use, Washington apple growers invested $1,500,000 in bins used to harvest 14 percent of the crop. Bins save money, time, storage space, and result in better harvest management and fruit quality. Their use—and a change in containers—forecasts a 10-fold drop in the 150 million board feet of lumber used a few years ago.

THE FOREST PRODUCTS INDUSTRY has shown interest in the comparatively new and rapidly developing methods of harvesting and handling fruit in pallet bins. This new type container is of concern to the industry since it involves large quantities of lumber and may necessitate significant changes by the present forest products manufacturers and suppliers of the fruit growing industry.

Pallet bins have been in commercial use for apple harvest in the Northwest only 2 years. However, Michigan also is extensively using bulk methods in the harvesting and handling of fruit and these practices are rapidly expanding into all of the major fruit growing areas of the United States, as well as many foreign countries. (1, 2, 3, 4, 15, 16 and 17).[2]

From around 25,000 bins in 1957, the number in use in Washington jumped to around 160,000 bins in 1958 (10). This represents an investment in bins alone of around $1,500,000. Over 5 million standard apple boxes of Washington apples were harvested in these bins in 1958, or about 14 percent of the crop. Over 400,000 bushels of additional fresh fruit, including pears and Idaho apples, peaches and prunes, were harvested in bins in 1958 in the Northwest (11), and another million and a half bushels in British Columbia, Canada, just across the International border (14). Altogether, about 186,000 bins were used in the area in 1958. The editor of WESTERN FRUIT GROWER in the October, 1958 issue, in referring to bulk bin harvesting wrote: "This is beginning to shape up as one of the fastest-moving developments ever to hit the fruit industry".

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[1] Presented at Session XII, Packaging, FPRS 13th National Meeting, June 28-July 3, 1959, San Francisco.

Pallet Bins

Pallet bins are also called bulk bins, bin pallets, bulk boxes, pallet boxes, tote bins and tote boxes.

Pallet bins, as used in the Northwest, are containers which usually hold about 25 to 27 apple boxes of fruit. A standard Northwest apple box has a volume about one percent more than a standard volume bushel. The bins are built with a pallet as a floor, and can be handled by conventional fork lift equipment. The outside dimensions are commonly 47 to 48 inches square and 29 to 33 inches high. Inside depths are commonly 24 to [illegible] inches. Their gross weight when filled with apples is approximately 1,[illegible]0 pounds, depending on bin capacity and type of design. Empty bins weigh from 100 to 150 pounds. They have nearly all been built of lumber, usually 1- by 6-inch boards, with 2- by [illegible] 3- by 4-inch stringers. Some have been built of plywood. Most bins have two-way-entry pallets. Costs usually have been from around $7 to $10 each (13).

Some rectangular bins have been built, usually about 42 or 43 inches by 48 inches, corresponding to pallet sizes already in use for palletized boxes in packing and cold storage plants (14). Most rectangular bins in [illegible]

[2] Numbers in parentheses refer to Literature Cited at the end of this article.

Loads for straddle carriers are set up on loading skids as the bins are brought from the orchards.

Straddle carrier backs over a load of 18 bins of apples to be transported to the storage plant.

Northwest have been built with four-way-entry pallets to enable stacking bins either way in cold storage. The square bins are preferred. They are more efficient for most handling operations, and with their two-way-entry pallets, are somewhat stronger and about $1 cheaper.

How Bins Are Used

A brief description of the operations followed and equipment used in harvesting apples in bulk bins will give a better understanding of bin requirements (7, 9 ,13). Empty bins, usually decked two high, are hauled from the packing plant to the orchard with highway trucks or straddle carriers. The bins on trucks are unloaded at the edge of the orchard by a fork lift tractor. Bins hauled by straddle carrier are merely set down on a loading skid consisting of a frame built from two, 4- by 6-inch built-up timbers resting on edge on the ground and spaced about 30 to 36 inches apart.

Empty bins are distributed in the orchard by one or two-man crews using low-bed orchard trailers, sleds, stoneboats, or tractor fork lifts. Pickers empty their picking buckets or bags directly into the bins. Filled bins are moved with tractor fork lifts to loading areas. From there they are hauled to packing or storage plants by highway trucks or straddle carriers.

At the plants, bins are handled with industrial fork lift units. Most filled bins are moved directly into cold storage where, in the newer storages, they are stacked 8 to 10 bins high. Loads on the bottom bins may, therefore, range up to around 9,000 pounds. Some varieties of apples or lots are run over the packing line in a few days, while others may remain in cold storage several months.

In the Northwest most bins are emptied with mechanical dumpers of the bin-inverting type (7, 13), or the tip-up type (8). Both are satisfactory. Some bins are emptied through a hinged or sliding door opening from the bottom edge of one side of the bin. Such bins require only a simple dumper or hoist to empty, but usually cost more to build and are less economical where large numbers of bins are used.

Advantages of Bins

Handling fruit in bulk bins saves labor and money. Cooperative investigations at the Tree Fruit Experiment Station, Wenatchee, Washington, between Washington State University and the U. S. Department of Agriculture have shown total savings from orchard to warehouse of 6 to 8 cents per bushel of apples harvested, when using bins instead of boxes (13). Labor savings for moving fruit from orchard to warehouse are from 17 to 25 manhours per 1,000 bushels or 3 to 4 cents per bushel by bin harvesting. Picking container costs are 2 to 3 cents less per bushel with bins. In addition, limited studies show that picking is around 8 to 10 percent faster in bins and usually costs somewhat less.

Changing to bin harvesting has also made it possible to improve harvest management, check on pickers better, and improve quality of fruit. Bruising can be reduced, and a more rapid movement of fruit into cold storage has been facilitated (12). Storage plant use of bins rather than bushel boxes on pallets increases the capacity by 20 percent or more (13).

Adoption of bin harvesting in the Northwest has been greatly speeded up by a major change in apple shipping containers. In the past, most apples from that section have been shipped in standard wooden apple boxes. Each year the new boxes were used for picking containers before being used for packing and shipping. Now, with a changed market demand, the fruit industry is rapidly changing to fiber cartons for shipping containers. This change is eliminating apple boxes as available picking containers. The choice of new picking containers is between picking lugs (approximately a bushel) at around 60 cents each and bins at around 8 to 10 dollars each, or about 35 to 40 cents per bushel capacity.

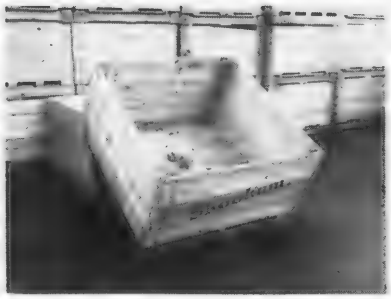
Significance to the Wood Industry

The large amount of wood products used, and the sources of supply involved in the change to bins and shipping containers, are important to the forest products industry. The change in shipping containers began before bins came into use in the Northwest and is not being caused by the advent of bins. However, the adoption of bins is interrelated with it.

A Washington state apple crop of around 33 million packed boxes, like the 1957 and 1958 crops which were around a fourth of the United States production, would take over 150 million board feet of lumber per year to ship if it were shipped in wooden boxes.[3] This market is fast disappearing. Of course, the fiber shipping cartons take wood pulp, but this means major changes in production of mills and factories supplying the containers.

Suppose that such Washington apple crops were picked half in bins and half in lugs and shipped in cartons. This may easily be happening in two or three years. Estimates are that over a quarter will be picked in bins and three-fourths packed in cartons in 1959. If a third of the crop is picked

[3] Based on the following footages: No. 36 Standard Northwest apple box, 4.79. (National Wooden Box Tariff No. 1); No. 1 Northwest picking lug, 5.23; 25-bushel pallet bin, 75 (approximate average for typical designs).



Bins with inside corner posts and no outside framing have maximum capacity for storage space occupied.

This bin holds 12½ percent less apples than the first bin, an important consideration for cold storage.

Bin of spruce plywood designed with four-way-entry pallet. Note cooling louvers at the bottoms of the sides.

during the picking season, which is about the usual practice, around 800,000 bins and 20,000,000 lugs would be required for picking.[4] These containers would require about 60,000,000 board feet of lumber for bins and over 100,000,000 for the lugs.[4] Assuming a 10 year life for both bins and lugs, this crop would require about 16 million board feet of lumber per year.

Thus, only about a tenth of the lumber formerly required to harvest and ship the Washington apple crop would be needed. Continued increase in use of bins would reduce this still more. These figures are based on estimates, but indicate the effect on the forest products industry of changes taking place in the Washington apple industry alone.

Major changes in suppliers of these containers are also taking place. In the past, "shook" for apple boxes or picking lugs has largely come cut to size from lumber mills. The use of bins is bringing manufacturers of pallets and bins into the picture. With little standardization of design or size of bins so far, the stock is being cut by large lumber yards, specialty mills, and pallet bin manufacturers, and not by the lumber mills. The bins are assembled by pallet bin manufacturers, by small contractors, and by fruit packing plants themselves.

Designs used in the Northwest have been largely a matter of meeting obvious requirements and personal preferences. However, there has been a continued pressure from the fruit industry for specific information on bulk bin design.

Use Requirements

The ultimate use of bins establishes certain general requirements:

1. Bins must be limited to an overall height into which apples can be emptied by pickers without injury to the fruit. The most convenient height is around 28 to 30 inches and certainly should not be over 36 inches.

2. Bins must be of convenient size for handling. Highway load width limits usually are 96 inches and much of the fruit is handled by highway trucks. Bins with dimensions approaching 96 inches in width or length are too large to be handled conveniently in orchards and around storage plants. To be practical they should be limited to 47 or 48 inches in grestest floor dimensions so that they can be loaded two wide across a truck. Such bins stack in rows in cold storage which are of convenient width for operation with industrial fork lifts.

Most tractor fork lifts used in the orchard have a capacity of around 2,000 pounds. Loads for maximum efficiency of fork lift handling consist of two 1,000-pound bins.

3. Bins must be made so that injury to the apples is avoided as much as possible. Inside surfaces must be smooth and edges of boards must be rounded to prevent cutting of fruit. Knots in lumber must be tight to prevent dropping out and leaving sharp edges. Bins must be strong enough to withstand excessive racking or bending of deck boards or side panels which tend to bruise fruit. Some bins are equipped with corrugated fiberboard liners to cushion the fruit against the bin sides and bottoms. Liners are hard to keep fastened in place and are not very durable, even though treated with oil or wax to increase water resistance. The liners provide some improvement in preventing injury to apples, but have not been used generally.

4. Bins must be strong enough to withstand permanent racking out of shape. They are sometimes rolled along on their sides or otherwise roughly handled in being distributed in the orchard. They are often filled on slightly uneven ground and twisted out of shape. They are sometimes bumped or shoved with a fork lift. Bins that become racked or twisted out of square cause trouble in bin dumpers as they become wedged or caught.

5. Pallets of bins must have adequate fork-entry space for picking up from uneven ground. Orchard surfaces are often irregular and the plane of the forks, determined by the tractor wheels, is not the same as that of the pallet. A fork opening about 3½ inches high has been recommended for pallets for orchard use, but some bins are being used which have openings only 2½ to 2¾ inches high and results seem to be satisfactory.

6. Bins must be strong enough to carry loads up to around 5 tons without danger when they are stacked in cold storage plants.

7. Bins must provide sufficient ventilation or heat transmission to cool the contents reasonably quickly in cold storage. Quick cooling of apples prolongs the storage life. Research done by the Agricultural Marketing Service, U. S. Department of Agriculture on cooling rates of apples in different types of bins indicates that ventilation spaces equivalent to about 8 to 11 percent of the bin floor or side panel area provide adequate cooling (7)

Bin Designs

Some characteristics of bin designs are of particular interest. The efficiency of bin capacity in relation to volume occupied has received attention. This is of particular concern in connection with cold storage space which costs around $1.25 to $1.50 per standard apple box to build or around 25 to 35 cents per year per box of fruit for storage. Three general types of construction are being used, one with inside corner posts and side panel boards on the outside of the bin and two types with the bin framing members on the outside of the side panel boards. With equal outside dimensions, the type with outside framing has 5 percent less capacity and another 12 percent less than the type with inside corner posts. A 100,000-box cold storage would cost around $20,000 more for bins of least capacity than for bins of largest capacity.

Bins with outside framing can be strengthened, however, by the ad

[4] Picking lugs or apple boxes hold about 33 to 34 pounds net weight of loose fruit as picked. Standard apple boxes have a minimum net weight of 40 pounds of packed apples and an average of about 42 pounds.

tion of diagonal members on the side panels. Some bins appear to be considerably stronger than others, but have not been tested for strength. The question is whether the additional strength will result in greater durability, and if so will that longer life or less maintenance cost offset the decreased capacity. It would be desirable to have accelerated-life tests which would simulate and be correlated with actual use and give information on bin durability in a few minutes or hours instead of waiting perhaps 5 or 10 years to get answers on strength and durability.

Certain design or construction features improve bin strength (5, 6). Plywood panels, for example, give greater strength against racking than lumber panels, but use of plywood usually increases bin costs. Perhaps the increased strength justifies the added cost. Use of wider boards with wider spread nailing increases strength. Deformed shank and clinched, plain shank nails hold better than plain or unclinched nails. Use of reasonably dry lumber resists warping, twisting, and splitting at the nails. Bins built of only partially dry lumber benefit by slow drying. Steel straps or bands are used around some bins for their added strength, but have faults. They loosen with changes of moisture in the bin and by use and they catch on other bins and equipment. The matter of strength is interrelated with that of rigidity. Bins should have some degree of flexibility to conform to uneven terrain when filled, and to withstand moderate shocks in use.

Another design characteristic being questioned is the use of bottom deck boards on the pallets. They have the advantage of strengthening the pallet and make stacking of bins easier. Their use also permits setting up straddle truck loads of bins from the end of the loading skids, usually a more desirable way to set up the load. Bins without bottom deck boards must be set onto loading skids from the side so that the bin stringers will set crossways with the skids. Bottom deck boards have the disadvantages of picking up dirt in the orchard and of taking up three-fourths of an inch of height per bin in cold storage. This lost space in storage amounts to around six boxes of apples in a stack of eight bins.

The use of fork slides is another design feature in question. These slides are boards nailed under and crosswise with the upper deck boards of the pallet. They protect the deck boards from being broken if fork points are brought up against them in the middle of the bin. They tend to prevent some fruit injury from bending up of deck boards. The disadvantage of the fork slides is that they reduce the fork entry space by three-fourths of an inch.

The method of providing adequate ventilation for bin cooling is still another question of design and also involves fruit injury. Any edge of a board against which an apple rests is apt to cause cutting or marking of the fruit. The best place on a bin to get a ventilation space and avoid board edges which might cut apples is to leave a crack an inch or so wide at the bottom edges of the side panels or at the outside edges of the bin floor. Such cracks at the bottom edges of the end panels may not be desirable as panel boards set down against the face of the deck boards help prevent the bin bottom from being sprung upward and possibly bruising apples. Furthermore, a careless fork operator might push a fork point into such an opening and damage apples or the bin.

A final point for consideration in bin design is bin repair or maintenance. It is very difficult and time consuming on some bins to replace a broken board in a side panel or pallet deck. On others, a board or a whole side panel can be fairly easily replaced. Accidents will happen to bins which will necessitate repairs. Experience with bins and information on bin damage is very limited but indications are that damage has not been great (7).

The matter of bin treatment with a wood preservative or a water repellent is questionable to many because of limited available information. Some plants are treating bins and others are not. The U. S. Forest Products Laboratory recommends treatment with a water repellent (6).

Research Needed

Research on pallet bins has been done by several agencies. Much of the work is reported in the references cited. Our agency is planning on little further research on bin handling of apples as the fruit industry has accepted the method and is going ahead rapidly. Personnel and funds will be expended on other more urgent phases of fruit harvesting mechanization. Other agencies are continuing research on certain problems dealing principally with packing and storage plant operation. More research certainly is needed on some phases, a few of which have been indicated in this paper. The change to bins involves millions of dollars of investment in bins, bin handling equipment, and packing plant and cold storage remodeling.

There is an urgent desire by the fruit industry for more information on strength, durability and economy of comparative bin designs. Bins must meet certain use requirements, such as convenience of size for filling and handling, prevention of injury to fruit, strength against racking or failure, and rapid cooling of fruit. Certain characteristics of bin designs, such as efficiency of capacity to volume occupied in storage, durability, and ease of repair need to be evaluated by further research. Assistance from the forest products industry will be appreciated.

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BENDING STRENGTH OF...

Particle Board Under Long-term Load

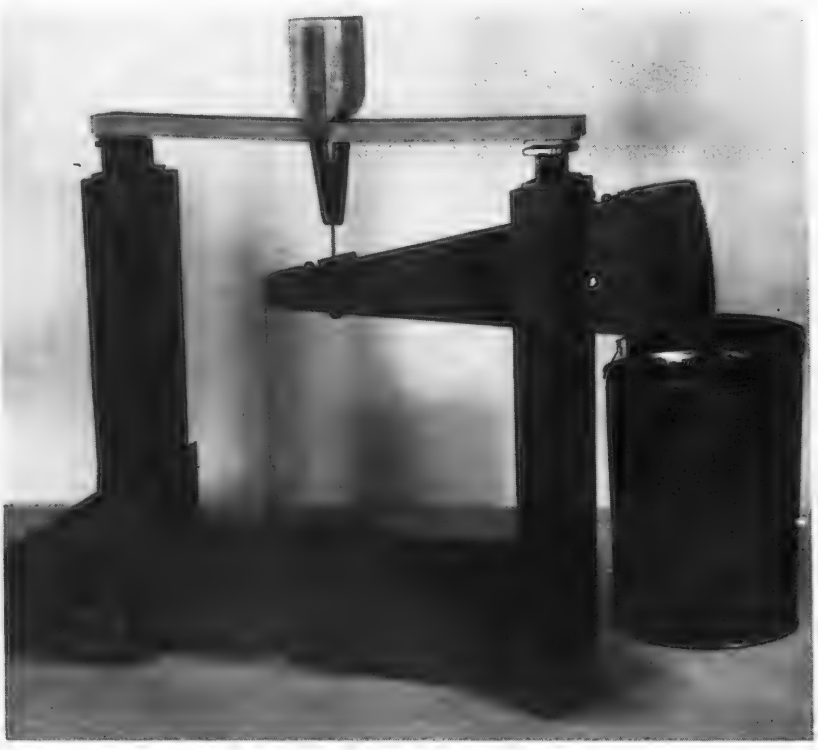

Fig. 1.—Long-term loading unit used to determine bending strength of wood particle board.

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High- and low-density particle boards made with urea or phenolic resins were tested in bending under long-term load. Failure and deflection data were obtained. Boards behaved about the same as whole wood of the same MC. Density and type of resin did not appear significant.

THE WIDESPREAD EXPANSION OF the particle board industry in the past few years was made possible mainly through the development of markets in the field of furniture core stock, floor under-layment, and other non-structural applications. It is very likely that many types of boards that are or could be produced would be well suited for load-bearing, structural members, such as sub-flooring, stress-skins, and diaphrams. The development of particle board for such use in the field of building construction could substantially advance this industry by opening vast new markets. Before structural applications develop, a complete knowledge of the strength properties of particle board should be gained, since this information is necessary in determining suitability for a particular use. Rheological properties should be included when material is being considered for use where long-term loads may be encountered.

Previous work has centered on investigating the influence of raw material and processing variables on the strength properties of particle board; it has been confined almost exclusively to testing under short-term loading. The length of time over which a load acts on a member greatly influences its deflection behavior and the stress at which it will ultimately fail. It is a factor that definitely should be considered when applying test results in determining the suitability of a material for an application where long-term loading is expected.

It is often assumed that wood fails according to St. Venant's general hypothesis that failure occurs when the deformation of the material considered reaches a certain value which is independent of time. Norén (4)[2] recently presented a theory in which he

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[1] Presented at Session XIX, Composition Board, FPRS 13th National Meeting July 2, 1959, San Francisco, California.

[2] Numbers in parentheses refer to Literature Cited at the end of this article.

th assumption to describe how the rat of loading affects the stress of fa re in wood. He considered, in detai the deformation during loading in its lastic and plastic components; the el ic component occurring in the ela ic cellulose chains and the plastic co ponent occurring in "viscous" eleme s. From these considerations he sh ed that if the stress is increased rap lly, the viscous parts of the wood str ure will remain firm and resist mu of the load. The elastic deformatio will predominate and the stress wil reach a high value before failure occ s. If the stress is increased slowly, the iscous parts will yield, thus causing he elastic parts to carry more of the load, which reduces the effective cross-sectional area. Since the ultimate strength of the instantaneously elastic cellulose is independent of time, the stress at failure will be less. These explanations of Norén might also be applied to long-term loading to explain how strength is affected by time.

A number of investigators have conducted experiments to determine the effect of long-term loads on the strength of wood. Riechers (5) loaded pine in tension at various stress levels and noted time to failure. By plotting the stress at failure against the time to failure, he obtained a "J" shaped curve which approached an asymptote at approximately 57 percent of the wood's strength as determined by standard testing methods. A similar relationship was found by Graf (3). Extensive tests conducted at the U.S. Forest Products Laboratory (6) indicated a somewhat different relationship. It was found that the stress at failure decreases linearly with an increase in the logarithm of the time of loading. The results of bending tests of Douglas-fir under various loads indicated that loading to 56 percent of the "normal strength" will cause failure after 27 years.

To the author's knowledge, long-term loading studies of wood particle board have been limited to a series of tests conducted in England (1) to determine the suitability of particle board for shelving material. Deflection was the prime consideration in the study and the loads used were small. A set of span tables for various types of wood particle boards was prepared from the data obtained.

The objective of the present study was to determine the general behavior of wood particle board when subjected to long-term flexural loads and to make possible a limited comparison of the material to whole wood with respect to the properties investigated.

Material and Material Preparation

Boards made with two types of resin binder, urea and phenolic, each of two densities, 0.65 and 0.80 specific gravity, were used in the study, which gave a total of four board types. Hammermilled Douglas-fir flakes were used for all boards, while the resin content was 8.0 and 6.0 percent for the urea and phenolic boards, respectively. In all cases, the final board thickness was 0.75 inch. All boards were of the three-layer type, having 12.5 percent of the total material in each of the surface layers. The surface layers differed from the remaining portion of the board only in that they were composed of thinner flakes.

All of the specimens used in the experiment were randomly selected from one panel, 4 by 16 feet, of each board type. The dimensions of each specimen were 2 by 20 inches. Before testing was started, the material was conditioned for 3 months in a controlled humidity room held at 30 percent relative humidity with a temperature of 72° F. When exposed to these conditions, the urea-type boards reached an equilibrium moisture content of 6.5 percent while the phenolic-type reached a value of 4.5 percent. The difference in these values is probably partly explained by a hysteresis effect since the phenolic boards were dried to 4.0 percent moisture content while in the press while the urea boards were dried to only 8.0 percent. Part of the difference is very likely due to a decrease in the hygroscopicity of the wood in the phenolic boards resulting from high press temperature.

Experimental Apparatus

Twelve long-term loading units were built for the study, one of which is shown in Fig. 1. The units were designed to deliver a constant load which is independent of deflection. Each unit has a maxium load capacity of 200 pounds and accommodates a specimen 2 inches wide, centrally loaded over a span of 18 inches.

Periodic deflection measurements were taken during the long-term loading test by means of a dial indicator which was held by a rigid frame in a position over the loading block of the testing units. The probe of the indicator extended to the upper surface of the loading block and, in effect, measured deflection of the specimen to the nearest 0.001 inch.

Before loading the specimens, the units were calibrated to the exact desired load by means of a special calibration bar. This consisted of an aluminum bar, ½ inch thick, of the same width and length as the particle board

Table 1.
RESULTS OF PRELIMINARY INVESTIGATION*

Load Level (per cent)	Average Time to Failure
90	7 min.
80	3 days
70	38 days
60	No failure after 104 days
50	No failure after 104 days

* Test material from high density phenolic board.

specimens with an SR-4 strain gauge attached to the center of one face. A calibration curve for converting strain to load was obtained for the bar in a universal testing machine under the same load and support conditions used in the tests. The testing units were prepared for each test by inserting the calibration bar in place of the specimen and adjusting the weight to deliver the appropriate load.

The time at which each specimen failed was recorded automatically by means of a recording potentiometer. A system of thermocouples was arranged so that as a specimen failed, a thermocouple connection was broken, and the event was recorded, marking the time at failure to the nearest minute.

Experimental Procedure

The first step was to determine the average modulus of rupture of each board type. This was done in accordance with the procedure set forth in ASTM Designation D 1037-55T (2) for the static bending test of building fiberboard, except that the specimen width was reduced from the specified 3 inches to 2 inches in order to reduce the load requirement of the long-term loading apparatus. Twenty specimens of each board type were statically tested after being weighed and measured in width and thickness to the nearest 0.001 inch. A load-deflection diagram was obtained for each specimen during the tests.

The load necessary to produce a stress equal to a given percentage of the average modulus of rupture was calculated by assuming the existence of a straight line relationship between the load and the maximum fiber stress. This assumption is not valid since it is based on Hooke's Law which holds only to the proportional limit. However, the assumption was necessary in this study since the true load-stress relationhip for stresses beyond the proportional limit is now known.

Preliminary tests were conducted to obtain a basis for the design of a working plan for the actual investigation. The tests included material only from the high-density phenolic-type board. Two specimens each were loaded at 50, 60, 70, 80, and 90 percent of the average maximum load obtained in the static bending tests. The tests were discontinued after 104 days of loading as

Table 2.
RESULTS OF STATIC BENDING TESTS

Board Type	Modulus of Rupture (psi) Average	C.V.[b]	Modulus of Elasticity (psi/1000) Average	C.V.	Specific Gravity[a] Average	C.V.
Urea, 0.65[c]	3,193	13.2	586	7.7	0.629	3.2
Urea, 0.80	5,064	8.2	839	4.1	0.792	2.3
Phenolic, 0.65	3,857	15.7	692	9.1	0.664	4.1
Phenolic, 0.80	4,847	5.7	810	4.2	0.802	2.5

a/ Based on volume and weight at test.

b/ Coefficient of variation (standard deviation expressed as a percentage of the mean).

c/ The figure represents the density of the board.

Table 4.

REGRESSION EQUATIONS FOR STRESS RATIO R ON TIME T AND CERTAIN POINTS ON THE REGRESSION LINES

Board Type	Regression Equation	Correlation Coefficient	Time at R= 100 per cent (hours)	Stress Ratio at T= 27 yrs. (per cent)
Urea, 0.65	R=77.89 - 2.089 log T	0.436	2.607×10^{-11}	66.67
Urea, 0.80	R=78.46 - 3.594 log T	0.771	1.016×10^{-6}	59.15
Phenolic, 0.65	R=82.30 - 4.050 log T	0.714	4.260×10^{-5}	60.54
Phenolic, 0.80	R=79.44 - 2.646 log T	0.530	1.694×10^{-8}	65.22

it was apparent from deflection measurements that no additional failures would occur within a reasonable time. The results of the tests are shown in Table 1.

A working plan for the study was designed on the basis of the results obtained in the preliminary study. It was decided to load four specimens of each board type at stress levels equal to 70, 75, 80, and 85 percent of the average modulus of rupture of the material. During the tests, it was found necessary to add tests at the 65 percent level, which gave a total of 80 tests for the study (four replications x four board types x five load levels). The maximum stress level was chosen at 85 percent so it would be no greater than the average modulus of rupture minus the coefficient of variation[3] for any board type. This criterion assured a minimum of immediate failures.

Before the testing was started, all of the necessary specimens were randomly selected and assigned to a load level. They were weighed and measured and the necessary loads calculated.

All of the tests were performed in the controlled humidity room in which the material had been conditioned. The testing was started by loading two specimens of each board type at the 70 percent level and one each at the 85 percent load level. As each specimen failed, it was replaced by the untested specimen most similar to it with respect to load level and board type. This procedure was followed until all of the tests were completed.

Table 3.

TOTAL TIME TO FAILURE DURING LONG-TERM LOADING TESTS

Board Type	Total Time to Failure (hours:minutes) stress ratio (per cent) 65	70	75	80	85
Urea, 0.65	660:05	142:38	9:51	16:00	0:01
	*	0:47	1040:00	16:31	0:01
	66:20	740:54	59:42	16:11	0:33
	0:07	596:42	119:28	102:52	32:54
Urea, 0.80	232:49	143:32	29:40	0:01	4:13
	741:14	145:10	5:08	0:01	0:40
	665:14	52:18	2:20	1:43	0:16
	154:52	122:36	22:33	223:07	0:03
Phenolic, 0.65	*	351:32	29:39	1:32	0:30
	81:26	1584:00	213:58	17:28	0:44
	69:05	81:46	132:26	336:38	0:04
	*	984:26	210:59	20:13	16:11
Phenolic, 0.80	*	12:10	141:56	81:26	2:50
	*	31:07	0:56	0:33	0:31
	164:12	188:45	550:00	2:38	0:34
	*	1263:00	0:02	2:41	15:22

* No failure after 1600 hours.

Results and Discussion

The results of the static bending tests are shown in Table 2. The table presents the average value and the coefficient of variation for the modulus of rupture, the modulus of elasticity, and the specific gravity for each board type. The coefficient of variation of the modulus of rupture was very large for all board types. It is interesting to note that the coefficient of variation of all of the properties is considerably higher in the low-density boards than in the high-density boards.

Since the specimens for the long-term loading tests were to be stressed to a percentage of an estimated value of their actual strength, it was felt desirable to obtain a more accurate estimate than the average value. An attempt was made to reduce the variation in strength by eliminating specimens of extreme weight. This procedure did not consistently eliminate specimens of extreme strengths nor did it result in a statistically significant reduction in variation. The possibility of using results of tests on side-matched specimens for predicting strength was explored, but this proved ineffective because of considerable variation within matched pairs. Therefore, it was decided to retain the arithmetic mean as the best estimate of individual values.

It should be noted that the results of the static bending tests are not exactly comparable to values obtained by the standard test since the specimen width was reduced by one inch. It is known that lateral internal stresses are encountered in wide, flat beams since the Poisson effect cannot take place completely. St. Venant's principle indicates that these stresses are first encountered at a distance from the edges approximately equal to the depth of the beam. From this, it is seen that the internal lateral stresses will increase as the width of the beam is increased. Although the maximum fiber stress at failure is not changed by this width effect, the strain is increased by the reduced width and therefore lower modulus of elasticity values are obtained.

[3] The coefficient of variation is equal to the standard deviation expressed as a percentage of the mean.

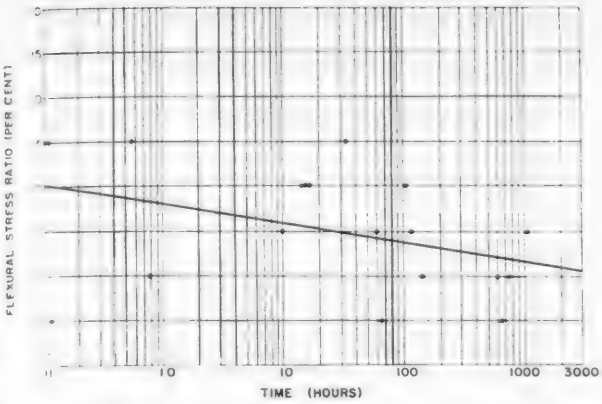

Fig. 2.—Experimental points and least squares regression line for long-term loading test on low-density urea-type boards. Regression equation: R = 77.89 — 2.089 log T.

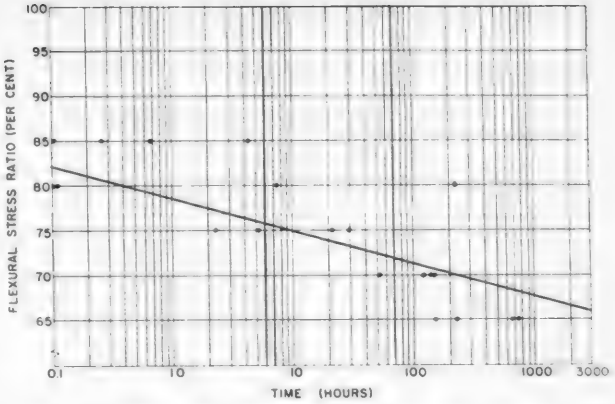

Fig. 3.—Experimental points and least squares regression line for long-term loading test on high-density urea type boards. Regression equation: R = 78.46 — 3.594 log T.

The results of the long-term loading tests are shown in Table 3. In many cases, total time to failure is seen to differ greatly among replications of a given load level and board type. This wide range of values is explained by the variation in the strength of the material (see Table 2).

The data in Table 3 for each board type are shown graphically in Figs. 2, 3, 4, and 5. The data are plotted on a logarithmic time scale since an exponential relationship between stress and time to failure appeared to exist. Straight lines were mathematically fitted to the data by the method of least squares. The regression equations for the lines obtained are shown in Table 4. The correlation coefficients for the relationships are also shown in the table. The relatively low correlation coefficients are explained by the high variability in the strength of the material and do not indicate lack of a definite relationship between stress and time to failure.

It appears that the relationships obtained do not hold for the entire range of load levels since extrapolation of the regression lines indicates that failure at the 100 percent stress ratio will occur essentially instantaneously (Table 4), which actually is not the case. This difficulty was not encountered in studies on whole wood. It is believed that the difference can be partially explained by the theory that in particle board, failure is more closely controlled by inherent flaws in the material. Stress concentrations associated with flaws in the material can cause abnormally high strain rates at high stress levels and, consequently, earlier failure. It is therefore conceivable that the relationships obtained by the least squares method can be valid for the lower stress level but change as higher stresses are encountered.

The probable change in the stress—time-to-failure relationship at the higher load levels may also be partially explained by the discrepancy between actual and computed stresses in the outer fibers beyond the proportional limit. As was stated above, in calculating the load necessary to produce the required stress, it was assumed that the stress varies linearly with the distance from the neutral axis of the beam throughout the tests. However, beyond the proportional limit, equal increments of load will produce successively decreasing increments of stress in the outer fibers. A load equal to 85 percent of the maximum load required to produce failure in normal static bending tests therefore produces stresses in the outer fibers equal to more than 85 percent of the maximum stress. This effect becomes greater as the stress ratio approaches 100 percent. A relationship expressed in terms of load rather than actual stress will therefore become increasingly inaccurate as the load levels increase.

In general, the results were quite similar for all board types. Since the large scatter of the data imparts a considerable degree of uncertainty to the constants of the regression equations, it is surprising how well the equations for the four types of board agree. It appears that the density and the adhesive have little or no effect on the stress—time-of-failure relationship of the particle boards investigated.

The stress ratio at failure for a duration of load equal to 27 years was calculated from the regression equations. The values obtained are shown in Table 4. It is seen that the lowest figure is somewhat higher than the stress ratio of 56 percent found for whole wood (6).

Ylinen (7) developed a mathematical expression which represented very closely the stress—time-to-failure relationships found by Graf (3) and Riechers (5). His formula was applied to the data of the present study and, when plotted, it was found not to fit the data as well as the regression equations shown in Table 4.

A typical deflection—time curve is shown in Fig. 6. This particular curve was obtained for a specimen from the high-density urea board loaded at the 65 percent level. It is seen that a definite point of inflection was encountered some time prior to failure. Wood (6) has described a similar occurrence in whole wood and stated that failure actually begins when the point of inflection is encountered. His theory was supported in this study in that the deflection—time diagrams for the six specimens which never failed showed no point of inflection. At the time the tests were discontinued, the deflection rates of the specimens were very low and were gradually decreasing.

Comparison of the last deflection measurements obtained for each specimen before failure indicated that the total deflection at failure is reduced by at least 15 to 25 percent as the stress level is reduced from 85 to 65 percent. The reduction in total deflection is actually greater than this since, in most cases, the last measurements obtained for the specimens stressed at the 85 percent level were made at a smaller percentage of the total time to failure as compared to the material at the lower stress levels. Also, the deflection rate beyond the last measurement was fastest in specimens loaded at the higher stress levels. The phenomenon is contrary to St. Venant's hypothesis that failure will occur at a fixed level which is independent of time. By observing the over-all deflection pattern in specimens for which the last measurement was made a short time before failure, it was found that the total deflection at failure minus the immediate deflection when the load is first applied gave a value approximately the same at all stress levels. That is, failure

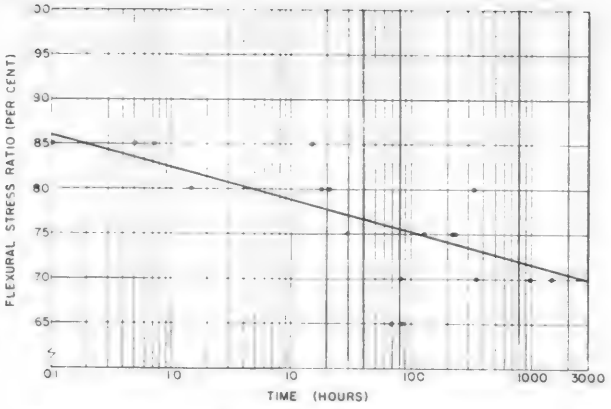

Fig. 4.—Experimental points and least squares regression line for long-term loading test on low-density phenolic-type boards. Regression equation: R = 82.30 — 4.050 log T.

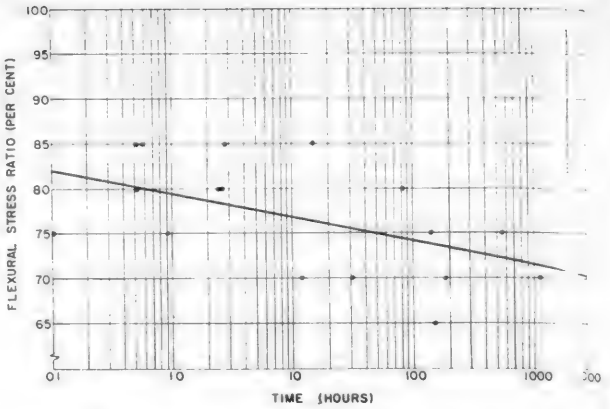

Fig. 5.—Experimental points and least squares regression line for long-term loading test on high-density phenolic-type boards. Regression equation: R = 79.44 — 2.646 log T.

appeared to occur when the "plastic flow" reached a certain level. However, the available data for this comparison were quite limited and the relationship cannot be stated with much certainty.

Summary of Conclusions

The conclusions drawn from the information gained in the study can be summarized as follows:

1. The stress at failure is reduced by long-term loading at an extremely fast rate to a stress level equal to approximately 80 percent of the materials "normal strength." Beyond this level, the stress at failure appears to decrease linearly with the logarithm of the duration of loading.

2. Board density and type of adhesive did not appear to have a significant influence on the stress—time-to-failure relationship.

3. Extrapolation of the data indicates that with a load duration of 27 years, the reduction in strength in the particle boards investigated is approximately the same as or less than that in whole wood. Because of the particular relationships obtained for particle board, reductions in its strength will be less than in whole wood for load durations of more than approximately 27 years and greater for shorter periods.

4. The deflection pattern in the particle board investigated is similar to that found in whole wood. A point of inflection is encountered in the deflection—time curve some time prior to failure and the rate of deflection is markedly increased as failure is approached.

5. Contrary to St. Venant's hypothesis, the total deflection at failure in particle board is considerably lower at the lower stress level.

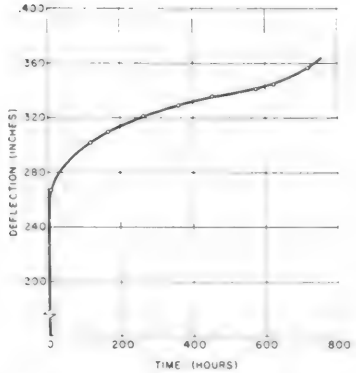

Fig. 6.—A typical deflection curve obtained from a high-density urea-type specimen loaded at the 65 percent stress level.

The above conclusions are based on tests conducted at one relatively low moisture content level with a limited number of board types. Tests including a range of moisture content levels and a greater variety of board types must be performed before specific design recommendations can be made for wood particle board in general. The results of the present study indicate that particle board for interior applications will behave much like whole wood when subjected to long-term loads.

Much more work is needed along the lines of the present study. Since there are many types of particle board commercially available which are produced in many different ways, further research should include production variables which could conceivably influence the strength of the material under long-term loads. In future studies, more complete deflection data should be obtained, perhaps by use of automatic recorders, since this will be essential for establishing relationships between the deflection at failure and the stress level.

The present study has obvious limitations which detract from the immediate usefulness of the results with respect to practical application. However, the information presented here gives a qualitative and, to a limited extent, a quantitative description and evaluation of a potentially important property of wood particle board which had not been previously dealt with in the literature.

Acknowledgments

Acknowledgments are made to Dr. A. P. Schniewind, Dr. E. L. Ellwood, Dr. F. E. Dickinson, Dr. J. E. Marian, and Professor H. D. Eberhart for their valuable guidance, criticisms, and suggestions. Special thanks are due to Dr. Schniewind for his close and active interest throughout the study. The author is also indebted to the University of California Forest Products Laboratory which made available its facilities, and to the Humboldt Lumber Division of Roddiscraft, Inc. which kindly supplied the material for the investigation.

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FOUR VIEWS ON THE QUESTION . . .

How Can the Plywood Industry Improve Control of Glue Bond Quality?[1]

1. The Trade Association's Responsibility

The association establishes realistic requirements and sees to it that they are maintained by member mills. It also gives service and assistance on gluing problems and conducts research to improve quality.

R. C. Raymond
Douglas Fir Plywood Association

THE DOUGLAS FIR PLYWOOD ASSOciation of the West Coast Douglas fir plywood industry, operates on a nonprofit cooperative basis, supported by the subscribers. The primary responsibilities of DFPA are to promote the sale of subscribers' plywood products and to assure the continued quality of these products. Quality is, of course, the prerequisite to continued sale.

While the burden of the responsibility for maintenance of glueline and grade quality lies with the manufacturer, the DFPA has an obligation to its subscribers to see that production bearing its trademarks meets certain quality requirements, thereby protecting the reputation of these trademarks and of all mills entitled to use them. It therefore operates a Quality Control Section for all subscribing mills.

Grade Marking

Before a plywood manufacturer is permitted to use DFPA grade-trademarks, his production must meet certain minimum glueline and grade quality requirements. Approval tests are conducted, following test methods outlined in CS45–55, on a number of panels in each standard thickness of each class of production manufactured by the plant.

Once a plant has qualified for use of trademarks, routine sampling and testing of its production is employed to determine its continued conformance to standards. A minimum quota of panels of each type of production must be sampled from each plant each month. No more than four panels are ever sampled from any one pressload. Results are reported to the mill as soon as possible after the tests are completed. A recapitulation of each mill's test results, broken down by glueline type, is prepared for each month's sampling. From this compilation it is determined whether standards outlined in the adhesive policy have been met.

If a mill fails to meet standards on a given class of production, an intensive sampling is carried out to affirm or disaffirm the below standard performance. DFPA, in the meantime, assists the mill to locate the source of bonding difficulties and take corrective measures. Should the intensive sampling test pass, the mill is permitted to continue using DFPA trademarks. If, on the other hand, the test fails, the privilege of using trademarks is withdrawn. Grade-trademarking privileges may be reinstated if the mill demonstrates in additional intensive tests that glueline quality is again satisfactory.

Adhesive Testing

DFPA also tests each adhesive made available to manufacturers by adhesive suppliers. To gain DFPA approval, an adhesive must meet requirements set forth in the adhesive policy. Test panels are sampled in at least three mills under normal operating conditions. The adhesive manufacturer's recommendations for minimum glue spread, maximum assembly time, and other gluing and pressing conditions must be closely adhered to in such runs. Only glues with DFPA approval may be used in plywood bearing DFPA grade-trademarks.

Specification Work

When requested to do so, the Quality Control Section also carries out glueline tests on plywood produced by subscribers for governmental purchasing agencies. These tests are conducted according to the requirements of the specification under which the plywood is produced, and shipments may be accepted or rejected according to the outcome of the tests. The government is thus assured that its plywood purchases will meet the requirements for which they are intended.

DFPA Research

The Quality Control Section also undertakes studies aimed toward improving glue bond quality of the industry as a whole or of an individual plywood plant. These range from long-term studies that have been continuous for the last 20 years to short studies requiring only a few days to complete.

Long-Term Research

Notable among the long-term studies is the exposure fence, which has been in existence since 1939, and now holds some 15,000 plywood samples glued with virtually every exterior glue ever used in the Douglas-fir plywood industry. Matching samples are cut into shear test specimens and subjected to the exterior boil test. Load and wood failure values are recorded and assigned to the matching exposed sample. Exposed samples are examined at least once a year, and delamination in excess of ¼ inch in depth and 2 inches in length is considered as failing.

It is through this work that DFPA is able to predict the performance of an exterior plywood panel, and to make recommendations to the industry for minimum glueline standards.

The Author: Robert Raymond holds a BS in ... stry from the University of Washington. He ... laboratory manager for DFPA.

[1] A panel discussion held during Session XIV, Glues and Gluing, at the 13th National Meeting of FPRS in San Francisco, June 28–July 3, 1959.

It was also through this work that phenolic adhesives with high ratios of protein or starch fillers were barred from use in exterior plywood bearing DFPA grade marks. Samples made with such glues delaminated after only a few years on the fence. It was concluded that the protein and starch fillers were, as a result of the constant wetting and drying, breaking down, and DFPA outlawed such glues in exterior panels. Research since that time has proven that limited quantities of these materials have no deleterious effect on delamination resistance, and they actually impart some desirable handling and spreading characteristics to the glue mix. In February 1958, since it appeared to be in the best interests of the industry, DFPA lifted the ban to allow the inclusion of amylaceous or proteinanceous materials not exceeding 10 percent of the weight of the resin solids of any exterior glue mix. Further studies have been ordered to determine whether this percentage can safely be increased.

Mold Resistance

Other long-term projects conducted include tests on the mold resistance of interior type plywood adhesives. Since plywood commercial standards and some government specifications require a mold-resistant glueline, mold testing of new glue formations or of new or varying amounts of toxic materials has been conducted continuously since 1950. DFPA has a fixed procedure for approving mold-resistant glues and insists that only approved formulations be used by member mills in the manufacture of interior plywood grades containing a mold-resistant glueline.

Glueline Tests

Industry leaders have for several years felt the need for higher bond-quality requirements for interior plywood and for a glueline test that could be performed in a shorter period of time yet be in line with conditions in actual service. Research conducted by DFPA led to the adoption of a new and more stringent glueline quality test for interior type plywood produced by DFPA subscribers. This test has since become a part of Commercial Standard CS 45–55 for Douglas-fir plywood.

Other Projects

Research undertaken by DFPA's Quality Control Section to evaluate the effects of gluing variables on glueline quality includes studies on: 1) exterior gluing of low-grade veneer, 2) glue bond quality of cold press plywood containing white pocket veneer, 3) exterior gluing of veneer from an oil-fired dryer, 4) cold press gluing of veneer from a gas-fired dryer, 5) effect of narrow backs on glueline quality, 6) effect of core laps on glueline quality, 7) effects of compression control upon thickness variation and glueline quality, 8) gluing of white pocket veneer with interior adhesives. Results of all studies which are not carried out for a member and kept confidential at his request are made available to member mills.

DFPA's Quality Control Section is now in the process of organizing a technical service to assist member mills with their gluing problems. When this service is ready to function, it will work in cooperation with DFPA's laboratory facilities and mill supervisory service, and it will be made available to all members.

Summary

The responsibility of the trade association for quality control, at least in the Douglas-fir plywood industry, may be summarized as follows:

1. To aid in the establishment of realistic test and glue requirements.
2. To conduct tests to assure that plywood bearing its trade-marks meets these requirements, and that glues used are capable of meeting requirements.
3. To keep mills informed of their glueline quality and factors affecting their glueline quality.
4. To give assistance with mill gluing problems.
5. And, through research, to evaluate and report the effects of gluing variables to member mills.

2. The Adhesive Companies' Role

Improvement in glue-bond quality must come from enlightened quality control of each step in the manufacturing process from peeling the log to the finished panel.

J. M. Hine

Borden Chemical Co., Seattle, Wash.

The importance to the plywood industry of constantly improving the quality of not only the glue bond but also the overall product can hardly be over-emphasized as competition for markets becomes intensified. In addition, the increasing activities of various regulatory bodies, such as the F. H. A., state architectural and engineering boards, and local agencies, make it mandatory that the highest quality product possible be turned out to avoid even more restrictive and costly requirements.

It is obvious, then, that there should be a continuing program of quality control in all phases of the manufacturing process, if the high quality necessary to keep and expand markets is maintained. In this program there are two major areas involved—that for which the mill is responsible and that for which the adhesive companies are responsible.

Once the raw material is selected the first practical step in which quality control can be applied is in peeling the log into veneer. The ultimate quality of the plywood has its beginning at the lathe, and the job done here influences the ease or difficulty of all succeeding steps. The equipment should be mechanically maintained in such shape that the smoothest, most uniform peel possible for the given log is obtained and close control should be kept to insure that this is done.

The next operation, clipping, is influenced by such things as the overall balance of the mill in production, edge-gluer capacity, maximum recovery of high grade, and type of log. And a good separation of heartwood and sapwood for best drying practices will prevent later difficulties.

The green grading also influences the future panel. Here further segregation of heart and sap veneer is made to eliminate as much as possible the inclusion of both in the dryer at the same time. Excessively rough veneer and grossly thick or thin veneer, which have been obtained in spite of close control at the lathe, should be graded out.

Drying high temperatures, whether obtained by steam or direct-fire, make it extremely difficult to produce good glue bonds. The inter-relationship time and temperature and their eff

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o. the gluing property of the wood sl uld be taken into account so that th dryer produces veneer that can be gl ed with little difficulty. The separ drying of heart and sap to the h hest practical degree should be eln tary, but this practice is often al sed. The dryer should be equipped w h moisture detection devices so that th narrowest practical range of veneer m sture content for the glue type to be sed with it can be efficiently prodd d. This will eliminate costly blistc and poorly bonded panels when th veneer reaches the press, often sever expensive steps later. There should be adequate cooling before the stock go s to the spreader.

Drying is about the first operation in which the adhesives companies can offer assistance. Some companies have made comprehensive studies of dryer operations and their effect on glue bond quality. Most of this information has been used for effective assistance in the mills. Several papers are also available on this subject.

After drying, the veneer is again graded, and there is another opportunity to eliminate rough stock and off-grade material which poorly bonds. The dried veneer should not be shoved off in a corner to stand for long periods before use during which time the veneer can pick up moisture again to the point where blisters, or over-penetration of the glue will result, or a deposit of resinous material can be formed on the surface of the veneer by exudation, especially in pine and other resinous woods, which makes it difficult to glue.

The sheet-patching and edge-gluing steps should also be controlled to eliminate abuses that effect bond quality. Veneers that are not suitable for good gluing can be mistakenly upgraded to where, as far as appearance goes, they are acceptable, but, because of their basic nature, they will not glue well. Veneer is often over-heated during edge gluing, producing hard-to-glue surfaces, and stock is frequently delivered to the spreader still too hot from edge gluing. Sloppy gluing results in excessive amounts of glue on the surfaces. Patches are often ill-fitting or lapped, and edge joints stepped, all of which will result in poorly bonded areas in the subsequent panels.

The glue mixing operations for these gluing jobs are frequently abused. The mix sizes are usually small, and small variations in the quantities of the various ingredients are often more important than larger discrepancies in the primary adhesive. It is disconcerting to the glue chemist who carefully balanced the mix in terms of pounds, ounces, or grams, to find that this has been turned into two coffee cans of resin, a fruit jar of catalyst, an orange juice can of water, and a heaping snuff can of hardener. The adhesive companies can be of great assistance, but their glue formulations must be properly mixed and handled.

So far, this discussion has been confined almost entirely to the preparation of the veneer, and its role in the gluing operation which converts it into plywood. The second necessary element, the adhesive generally comes to the mill from independent adhesives companies, or from integrated adhesive plants. Resin must be stored in reasonably clean tanks, and precautions taken against mixing resins obtained from different manufacturers. The proteinaceous dry glues should be stored in a dry, cool place, and the oldest glue should be used first. Defective glue actually gets into a mill only rarely, and it is usually found very quickly when it does; therefore, it will be assumed here that the glue is a qualified product, fully capable of producing high quality plywood bonds if properly used. It is essential, however, that the glue be mixed in accordance with the manufacturer's instructions, and that the amounts of ingredients be controlled as closely as possible. While most glues have a good safety margin and can tolerate some variations in the various ingredients, the proportions given generally give the optimum performance. Weighing and metering devices should be used in determining the quantities added, and the devices themselves should be calibrated occasionally to be sure they give correct readings. The mixer, hold tank, pumps, and lines should be kept clean and in good condition to insure good mixing and to prevent contamination.

Adhesive companies have assisted mills with glue loft layouts, tank calibrations, glue mixing instructions, and other aids to insure that the operation is set up and equipped to carry out its function properly.

The veneer and glue finally come together at the spreader which must be kept clean and in top shape. The rolls should have the proper type and hardness of rubber, if they are of this type, and the grooving should deliver the right amount of glue in the correct pattern. Here, the characteristics of the glue to be run on them, as well as the spread weights desired, enter into the selections of rubber and grooving. Most adhesive companies have specifications available for this step.

In use, the spreader should be properly adjusted to deliver the specified weight of glue, evenly distributed between top and bottom of the veneer and across the width of the core. Adjustments should be made periodically to take care of changing conditions, and frequent checks of the spread weight should be made. The minimum weight of glue must be maintained to do a good bonding job and prevent starved glue joints, but an excess will often lead to undercure, and always to higher glue costs than necessary.

The lay-up practices in conjunction with the spreading also have a bearing on the quality of the finished product. Careful attention should be paid to wipes, core gaps, exclusions of knots, splinters, etc., lapping of cores, and rejection of poorly spread cores. The assembly time limits prescribed for the glue should be adhered to. When pressing, the precure between the time the panels are loaded and the time under pressure should be held to a minimum. The time, temperature, and pressure specified by the adhesive manufacturer should be carefully followed. Periodically, the timers, steam traps, and pressure gauges should be checked. The amount and quality of the steam should be investigated occasionally, since the platen temperature can seem to be right according to the recorder, but the heat in-put can actually be too low to bring the glue line up to curing temperature fast enough.

The operation of the press is still another area in which adhesive companies perform useful services, measuring platen and glue line temperatures, both for their own information, and at the request of the mills, to obtain a good picture of the press performance.

After pressing, the panels should be held in the loader a minimum time, cover boards should be used on the stacks, and the recommended minimum time between pressing and sawing should be observed.

The adhesive companies perform a final service in testing the product, and advising the mill as to what it actually has produced for glue-line quality. These tests supplement those made by various testing organizations for their member mills, or, frequently in the case of non-affiliated mills, are the only tests available to the mill as a measure of its performance.

From the adhesives manufacturer's view point, then, improvement in control of glue-bond quality must come in large part from enlightened quality control of each step in the whole process of manufacturing plywood, from the peeling of the log to the finished panel. While research for new and better glues goes on in numerous laboratories continuously, the day is not yet in sight when the plywood mill can deliver a stack of badly prepared, mistreated veneer to the spreader, say to the glue man, "Glue it," and expect the adhesive to produce a high-quality product. Every inherent good property of the wood must also be utilized to the fullest extent possible.

3. A Production Responsibility

K. K. Graves
Georgia-Pacific Corporation,
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Quality for the industry must be achieved on an individual mill basis. It is an hour-by-hour problem that must be solved on the job. People, training, and supervision are the key.

When a customer receives plywood of inferior quality or off-grade, the results are always the same, only varying by degree. Regardless of the past performance of the supplier, this shipment of off-grade material cannot help but shake the customer's confidence. There are countless conditions under which this shipment could be vital to the customer. For example, in the case of an industrial user, it may be that car which was so urgently needed in his cut-up department to fill a scheduled shipment; or in the case of a contractor, the material may be what he needs to keep his roofers or formers on the job. The fact is too well known that most customers carry as small an inventory as possible, and he depends upon his suppliers to furnish, on schedule, (always his) the material which he needs —material on-grade.

The customer's supplier, who could be a wholesaler, jobber, or direct mill sales department, can and will, often stop a complaint or claim without kicking it back to the mill. This does not erase, in any manner, the customer's ire. Having settled the claim, the supplier now turns to the mill, or passes to the mill if he hasn't settled, both the monetary loss and his loss of confidence. That this is becoming a snowball is obvious, and sadly, the truth.

For years we have heard various mill people brag about having never lost a reinspection claim. How commendable! This is the same attitude one finds about wars. Whether it will be admitted or not, both sides lose on a claim or a complaint. Claims are immediately identifiable with dollar loss, however, loss of confidence also has its compounding monetary loss to the customer, the mill, and the industry.

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Looking Back

The problem of quality for the industry can only be solved on an individual mill basis. It is because of this that the associations and commercial standards exist. Standards without supervision and control are not standards at all. We have only to look back a few years to remember that prior to the creation of a supervising control body the plywood industry was in the same boat as the hardboard industry is today. Each mill had its own product standard, each customer had its own use standard, and those in the middle, again the salesman, were in constant trouble with each end in their effort to fit the product to the end use. Douglas-fir plywood was a dog in those days, with but one type of glue available in commercially economical quantity; the "sandwich" was repeatedly used where it should not have been. This young and blossoming industry had some real problems to overcome. Looking back on it now, we haven't done too badly. Looking ahead, we have as much or more to do than that which has been done.

Face the Facts

Quality of product is vital to an industry; perhaps more so than any other facet of consumer-industry relationships. It is even *more* important, however, to a company within that industry. An industry which continually progresses with controlled standards, new developments, and aggressive consumer relations will outstrip and leave behind an individual member who turns his back on quality and production control.

Quality control in the manufacture of plywood goes much further than the adhesive in the glue line. This truism is generally overlooked, however, by many in our industry. Obviously, it is much easier to blame our defective merchandise upon those who are not present or whose product is one over which a mill has little control, than to face the facts found in the whole ledger.

Lathe, clipper, dryer, jointer, and core defects are all familiar items to us, and we all know the effect each has upon quality of our product. Our problem consists chiefly of the lip service we give to these, our own defects. We almost universally receive our manufacturer associations' quality reports on our individual efforts with a tongue-in-cheek attitude. Part of our dues are paid for the purpose of their inspection, but how many of us are guilty of pouring our money down the proverbial rat hole and continue to go our own way doing just enough to keep our stamps?

Threefold Problems

Let us turn, then, to our own back yard, and instead of moving our bank into the neighbor's yard, as Mr. Mery did in "Gasoline Alley", let us take some positive steps to clean up.

Wood

Our problem consists of three elements; wood, machinery, and people, and these are, in my opinion, in inverse order of importance. There is little any of us can do about wood other than complain about supply and price. It is true that we can, and are, beginning to assist mother nature by improved forestry techniques, stand improvement, silviculture, and so forth, but we here present will not reap the values of these efforts. Consequently, we must continue to live with knots, pitch, bark, grain, decay, and shake.

Machinery

Machinery, however, is a factor over which we do have at least some control. Maintenance must be a continual program for any manufacturer if he is to survive in this day of increases. At the lathe, for example, we must maintain constant vigilance of spindles and bearings, feed screws and nuts, carriage ways and pitch rails, pressure assemblies and head slack, roller bars, and knives. If all of these are up to "snuff" the lathe will do the job the demand of it.

Clippers must have continuous surveillance to insure accurate width control and to eliminate torn edges. Dryers have a list of maintenance problems as long as your arm, critical points upon which veneer moisture content, color and condition depend.

Veneer processing equipment, including jointers, tapers, edge glue, pluggers, patchers, and core saws,

must be kept in top condition in order to produce an end product, on-grade, with a minimum of panel patching and re-patching.

All of these steps now bring us to the press room, where whatever effort has gone before is either put to good avail, or thrown down the drain. Glue room house keeping cannot be overemphasized, spreader rolls, doctor rolls, bearings and drives must all be in optimum condition; the same applies to the press platens, rams, packing, pumps, timers and temperature controls. Saws must be kept sharp and true, sanders level and with good felts and paper.

We could go on all day, item by item, and I have only gone this far, in detail, to firmly establish the understanding that there isn't a piece of equipment in the plant, be it lathe or spring scale, that doesn't effect the quality of product and, therefore, the profit of an operation and the success of our industry.

Maintenance personnel must be constantly exposed to new and improved tools. It is upon this small segment of the payroll that we depend for production with a minimum of breakdown and lost time. Frequently, however, we tie their hands by refusing a request for a portable welder, or some other tool. Lost time due to breakdown is gone forever. Poor quality because of poor or inadequate maintenance is worse, for we not only lose the customer's confidence and money, but we also lose the production that should have been on-grade.

There comes a point in every plant's life when there is just nothing left of a piece of equipment except brassing rod, stiffners and cap screws—weld upon weld! When this period is reached, production management must face their responsibilities and replace or renew. A glue spreader, for example, with broken end frames not only fails to keep up production-wise, but will not spread properly, causing excess glue cost or down-grade panels. Let us face it; a new spreader would cost us several thousand dollars installed, but we could pay for it in just a few months with the glue saved and increased production alone, to say nothing of the reduction of reject panels resulting from improper spread. This philosophy must extend throughout the plant.

Today we are building plants with equipment unheard of even 5 years ago. Many are new and untried, loaded with "bugs", but each one potentially capable of producing a better product with fewer people. A word of caution, however, these new gadgets are not foolproof. Maintenance is even more important on them than some of our old steam age equipment. Today machines are faster, lighter, more automated, with intricate circuiting and controls. Voltage and air pressure control is more critical than ever before. Take care of your production equipment. Your business and our industry's life depends upon it. If we, as individuals, can satisfy ourselves that every piece of equipment in our operation, from the pond saw to the fork lift at the loading platform, is in as good condition as possible, then we can turn with clear conscience to people we hire to use this equipment.

People

Basically it makes very little difference how eager an employee you have, how skilled or proficient he may be, or how hard he may try, he cannot do a good job for you without constant training, and supervision. How many of us as shift foremen have grabbed a new man, dumped him at the green chain and hurried off to the pond with these parting words, "Pull the fish tail, that guy will show you how?" Sad? But true. A few minutes to show the poor fellow what fish tail is, how to get that little snap in the wrist, how to tie the load together so that it doesn't fall apart when he kicks it out for the lift truck,—not important? Every man on your payroll is important, particularly the greenhorn.

Being first and foremost a production man, there is nothing which pleases me more than a daily report showing a new record for lathe or dryer production or core footage layed during the shift. We all can appreciate the benefits gained by the fostering of competitive spirit between crews. However, production per se, without the control of the quality of core laying, glue spread, sheet turning, and press loading is not only expensive, it is a shameful disregard and waste of human effort, machine time and materials. Lapped and gapped core, split faces and backs, sloppy laying and butting of centers, thin and short core that should have gone into the box are all man-made defects that show up percentage-wise as the largest contributing factors toward our product's quality failures, and gentlemen, they are all consummated by that four man gang known as the spreader crew. Couple to the defects described above, an inadequacy of the most easily controlled factor of all, glue spread, and you have lost the whole package.

I am not saying that more glue is the panacea for quality problems, but I am really talking to the operator who does the whole job beautifully up to the spreader and then says "spread her a little thin boys, I will pay a few claims and still come out ahead". This philosophy may be all right at the dryer where we get another crack at wet stock by redrying, but I certainly do not believe it is the economical thing to do when we are finally putting our eggs into the little yellow basket.

People, training and *supervision* again are the key. Train the personnel to the point that they know not only their own job, but the one on each side of him, supervise him so that he feels needed and important. Develop a sense of pride of workmanship and then maintain a constant stimulation of this pride and we have taken the biggest possible step toward quality of product and capacity production. This is our biggest and toughest job, and also the most important, for truly, *people* are the most important factor in production and product quality.

Local Responsibility

Basically Georgia-Pacific Corporation is completely decentralized from a production management standpoint, an operating policy which is imperative in a company as large and diversified as we are. As most of you are aware, we are producing over 600 million feet of Douglas fir plywood a year in 7 different plants in 3 different states. Our timber type varies from the legendary Puget Sound old growth to the California second growth. This is about as big a spread in one specie as you will find. Our mills number from one of the oldest, to the two newest. In view of these and other conditions, quality control is, naturally, a local mill responsibility in all regards, and from the overall company standpoint, executive production management is interested only in the results.

The mills do, however, follow a close pattern in their control procedure. It is generally a simple one, one with which we are all familiar and one which is fairly universal within the industry. In each mill we have a quality control supervisor or equal who, along with the floor man and/or glue checker on each shift, is directly responsible for veneer grade and quality, glue spread, panel sawing, patching, sanding, and all aspects of production which affect quality.

The sander graders' report will indicate when a constantly occurring defect, such as short core, may exist, but it is our philosophy that this must be corrected *before* it reaches the panel grader. For this reason, the shift foreman and other supervisors continue to be primarily responsible for the constant vigilance of quality from the block saw through the entire plant.

The fact that we may have a quality control supervisor in no way relieves the foreman and superintendent of this responsibility.

That we depend upon our associations for testing our product for compliance with accepted standards is not unusual, nor, I believe, a "poor substitute" for our own responsibility. Quality control, which we must have, is a constant hour by hour problem and one which cannot be done from a laboratory, whether it be company owned or association operated. The time to correct quality deficiency is now, not a few days or weeks later when the laboratory report comes back. The place to correct quality deficiency is at the mill where it exists, and the responsibility to correct quality deficiency lies squarely in the lap of production.

4. Management's Responsibility

H. W. McClary
Simpson Logging Company
Shelton, Washington

Quality is management's job . . . developed from the top down. It doesn't start with the per diem worker and permeate up . . . but the worker will put into the product what management wants, if properly directed.

BEFORE WE CAN CONSIDER MEANS of improving control of glue bond quality we need first to look back briefly and generally at progress that has been made in the industry since its beginning, and give proper recognition to those who have contributed in bringing our glue bond quality to the high standard it is today.

While considerable plywood is made throughout the United States and also in furniture factories in the west, any reference to the "plywood industry" in this paper is meant to embrace only the fir plywood industry, consisting of DFPA and non-DFPA mills.

The First Plant

In 1905, the Portland Manufacturing Company was the only manufacturer of Douglas-fir plywood. Today we have 143 mills producing approximately 7 billion square feet of Douglas-fir plywood, and steady and worthy progress has been made in both glues and glue bond quality.

Soybean Glues

Hot animal glue, spread with a brush, was the first adhesive used in the Portland plant in '05, and pressures were obtained with a screw press. Starch and casein glues were later used, but the industry made its real growth with the introduction of soybean protein glue in 1923, with wide industry use of soy protein by 1927. Bonds were restricted to interior quality and were undoubtedly of questionable character by today's standards.

The Author: H. W. McClary, vice president and general manager of Simpson Logging Co., is a graduate of the University of Washington.

New Presses

The advent of the much-needed hot press and exterior glue to bolster the sagging plywood market of the times, and to extend plywood usage to the outdoors, was the result of Dr. Nevin's work with cresylic acid in the early 30's. A waterproof glue was perfected in 1934 by Harbor Plywood, but the press temperature required was very high (330°F) and the press times long, which necessitated panel humidification.

Improved Product

Continued progress was made through adhesive research in private and commercial laboratories, and many new and modified glues were developed and made available to the industry which not only provided improved glue lines, but glue lines of lower cost. Machinery developments provided the industry with opportunities to improve its gluing techniques. The resulting improved plywood product needed only the combined promotional effort of the existing manufacturers through their plywood association to put plywood "on the road". The phenomenal growth of the industry since the real inception of the Plywood Association in 1936 is a matter of record.

Pioneer Service Men

How the plywood industry survived the early days, as we compare current knowledge of adhesives with that of early years, is miraculous. Quality control was virtually unknown. The plywood industry as late as 1935 had only one inspector, Oscar Mason, whose work was confined largely to panel grades. The adhesive manufacturers were virtually forced to provide technical guidance and service at the plants in the arts of mixing and spreading the glues they offered. Pioneer service men such as Wes Shelley virtually covered the industry alone—an industry which until 1936 except for the Portland mill, was confined to the Puget Sound country in Washington.

Association Work

With organization of the Technical Department of the DFPA in 1936, and an inspection and testing service to assure consumers of the quality of DFPA trademarked plywood, an analysis of accumulated data from laboratory testing and exposure walls paved the way to more critical test procedures and higher test requirements which were promptly written into manufacturing and commercial standards to assure improved glue bonds.

In 1936, Nelson Perkins, Technical Director of DFPA, and Gus Arneson, the Inspector-in-Chief, developed the 2-cycle moisture-resistant test. To provide a more durable quality of bond for hutment-grade plywood, in the early days of World War II, the DFPA developed the 10-cycle test which became criterion not only for hutment plywood but later on for concrete-form plywood.

The DFPA exposure wall was started in 1938 to correlate laboratory "wood failure" with actual performance under field conditions, and in that year exterior-type plywood and glue line performance were written into commercial standards with a 60 percent wood failure requirement. As the result of exposure fence analysis, wood failure requirements for exterior plywood were raised to 80 percent within a few years. The blood-phenol adhesives widely used in the early 30's were quickly classified on the exposure wall as being inferior to straight phenol resins.

The never-ending vigilance on part of the DFPA inspectors, laboratory, and technical departments, improve glue bond quality, has sulted in continued improvements testing and evaluating glue and g bonds. The current rigid Adhesi Policy of the Association, develop through years of experience in deali

wi all kinds of companies and con-
di ns, has been most instrumental in
p ing a rapidly growing industry in
th maintenance and control of glue
b quantity.

Today's Association

the present time the DFPA has
51 spectors, including 2 regional
ma gers, visiting 122 member mills.
Th ommercial glue companies have
ap ximately 75 sales and service
m calling upon the manufacturers
an orking in their operations. These
tw roups, the DFPA inspectors and
the lue company sales service repre-
sen ives, can be thanked primarily
for he current high quality of glue
bon The character of the service of
thes two groups, due to their spe-
cial d training, has been excellent,
and ney are recognized in the industry
for eir willingness to assist in any
kind of problem relating to glue line
quality control.

In spite of the capabilities and potentialities of these men it is too well-known that they are virtually without "portfolio" and without authority to correct a mill condition other than to report their findings to a foreman, superintendent, or manager, who might or might not do something about correction. Management has often been complacent about reports from DFPA inspectors or glue company service men, and has had grade-mark stamps lifted or qualifying runs to make as costly penalties. There probably isn't a commercial glue company in existence that hasn't had its glue forced out of a half-dozen or more mills on the pretext that the glue was faulty, whereas a forthright appraisal of facts would justly place the blame for poor results on improper mixing, wet or poorly cut veneer, inadequate spreads, over assembly times, or equipment improperly operated or in poor condition—things over which Association inspectors and glue representatives have no control.

Part-time Programs

In the entire industry, out of 137 mills operating today, there aren't 6 or 7 companies that have full-fledged, around-the-clock programs on quality control in effect. The mills over the years have relied upon, and as a matter of habit have become accustomed to expecting, assistance and guidance from people outside their own organization; yet a DFPA inspector, unless a mill is in trouble, seldom visits a mill over twice a week for a total of about 12 hours, and a glue company representative might only visit a mill once a week for 4 or 5 hours—more often if a competitive glue company is actively working on the account.

Plywood is made 24 hours a day 5 days a week, and a control program geared to 15 or 20 hours per week of plant visitation doesn't answer the problem to our question: "How Can The Plywood Industry Improve Control of Glue Bond Quality?".

Needed: An Awakened Management

Improvement in the control of glue bond quality can only come through an awakening on the part of top management that quality is a matter of policy. Quality is a manufacturer's responsibility. Quality is developed from the top down. Quality doesn't start with the per diem worker and permeate up through an organization, but the per diem worker will put into the product what top management wants —if properly directed.

Association inspection of panel grade and the testing of glue line quality is necessary to assure a uniform interpretation of manufacturing and commercial standards among the mills. Knowledge of such conformance is necessary to support the Association trade promotion program and the inspection certificate. However, mill management should know that its production meets the required standards on a day-to-day basis and should not be dependent for such assurance upon test reports forthcoming from outside sources 10 or fifteen days after sampling.

Needed: Full-Time Control

The Association and glue companies have contributed in the largest measure to the development of the existing high standard of glue bond quality. Their continued effort in control of glue bond quality cannot be slackened or depreciated until management accepts the responsibility that is rightfully its own and for which a manufacturer is morally obligated to its customers. A re-examination by management of its objectives and responsibilities in business will dictate that maintenance, control, and improvement of glue bond quality can only be achieved through the organization and establishment of a full-time quality control program dedicated to the achievement of management objectives.

A management-sponsored program to assure glue bond quality necessitates adequate quality control at every operation where veneer is being prepared for gluing—this means at the lathe, the dryer, the patcher and edge gluer. Improved control of glue bond quality necessitates good maintenance of mixing, spreading and pressing equipment, with gauges, meters, scales, moisture detectors, all in good working condition; and good housekeeping involving dryer rolls, mixer, spreader and press platens. Improved control means the proper amount of glue spread, with the panel subjected to correct assembly time, temperature, pressure, and curing time.

Control Teams in Every Mill

The plywood industry's greatest opportunity to improve control of glue bond quality lies in individual mill management's recognition that quality is being affected in every operation and at all times adequate, competent, technical personnel must be on hand or recruited into production to cope with the peculiar problems of the mill involved. With properly trained and experienced personnel understanding the correlation of factors affecting glue bond quality and product quality, supported with the authority of the management to make corrections necessary to improve conditions as required, the industry will improve control of glue bond quality. Such a company quality control team in each and every mill would permit adhesive companies the opportunity to concentrate on research with the full knowledge and assurance that their products were being properly used within the tolerable limits supplied by the adhesive manufacturer, and under the most favorable plant conditions. The association inspectors under such control program would need only to substantiate, in effect, quality which already had been assured through the mill's own laboratory testing.

A Moral Obligation

With consistent quality in adhesives, resulting from the adhesive manufacturer's own close controls on incoming raw materials, cooking, and blending processes to assure uniformity, the plywood manufacturer can improve control of glue bond quality by accepting the full responsibility for usage.

As initially set forth, the problem at hand is not a scientific one. It doesn't involve complicated mathematical formulae or principles of nuclear or even elementary physics but only the simple acceptance by production management of its full and moral responsibility for operating its own business.

Glue savings and a reduction of claims for product failure compensate many times for the cost of improved control, and there is no better place for the training of future executives than in the technical phases of operations.

Yes—the plywood manufacturers themselves have it within their power to provide the industry with improved control of glue bond quality.

INFLUENCE OF EXTRACTIVES ON

Seasoning Stain of Redwood Lumber[1]

A. B. Anderson, E. L. Ellwood, Eugene Zavarin, and R. W. Erickson
University of California Forest Products Laboratory, Richmond, California

Chemical brown stain in redwood has been attributed to the tannin-polyphenolic components in the extractives. Varying the drying schedules does not appear to provide a means of controlling the stain, but preliminary results indicate that presteaming the lumber may reduce occurrence of stain.

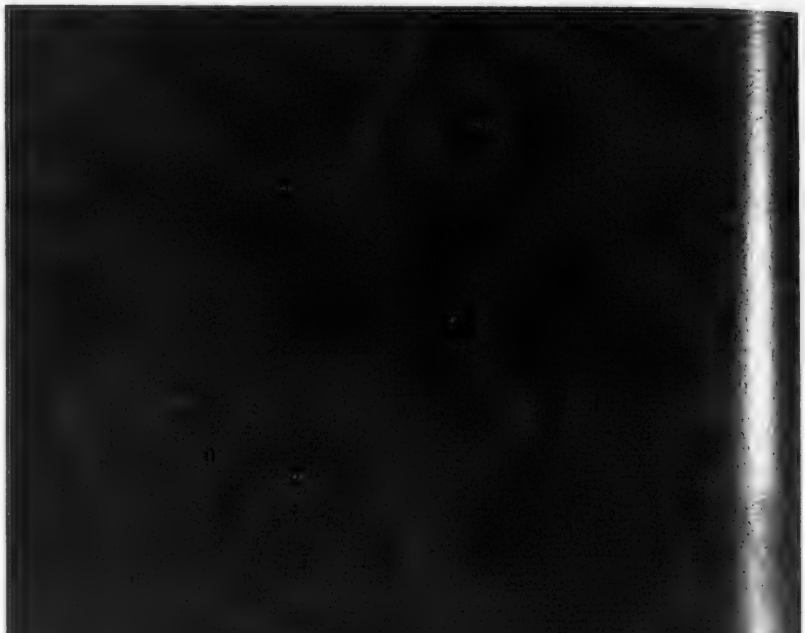

Fig. 1.—Top, sticker-stained redwood board; Bottom, unstained board.

THE PLEASING AND DISTINCTIVE COLOR of redwood (*Sequoia sempervirens*) results, in part at least, from the nature of its extractive components. Also, the excellent durability of redwood heartwood in service is attributed to the fungicidal properties of its extractives (1, 2). Thus, it is apparent that extractives are largely responsible for redwood's distinctive characteristics.

One of the problems associated with the manufacture of redwood lumber is the chemical seasoning stain, again resulting from the chemical nature of some of the extractives (Fig. 1). This dark-brown to blackish stain, which may appear as streaks, in patches, or as sticker stain, is most likely to occur in heavy redwood sinker stock generally derived from the peripheral and intermediate heartwood region of the butt log. This material is usually highest in extractive content and very high in moisture content (1, 2).

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Nature of Redwood Extractives

Redwood may contain from 15 to over 30 percent extractive components. The greater portion of this extract is water soluble, and consists largely of tannin, other polyphenolic compounds, and cyclitols, polysaccharides, and simple sugars. The water insolubles, which are largely soluble in hot alcohol, consist of polymerized tannin, phlobaphenes, and other coloring matter.

One of the peculiar characteristics of redwood extract is the extremely labile and hygroscopic nature of the water soluble material. If an aqueous extract of redwood is concentrated by conventional laboratory vacuum distillation procedure, the resulting concentrate is a very dark brown-black syrup which does not lend itself to analysis. On the other hand, if aqueous redwood extract is lyophilized or freeze dried the resulting product is a grey-pink amorphous powder which is more amenable to analysis. It was observed that the degree of hygroscopicity of the resulting product was contingent on whether air-dried or fresh green redwood sawdust was used in the preparation of the extract. When air-dried sawdust was used the resulting amorphous material began to pick up moisture at about 75 percent relative humidity. On the other hand, when the extract was prepared from fresh green redwood sawdust, the resulting material was generally so hygroscopic that, as soon as it was exposed to the atmosphere, it began to pick up moisture immediately, and turned to a viscous liquid which gradually darkened on subsequent exposure.

The freshly prepared, lyophilized aqueous redwood extract can be separated into a tannin and non-tannin fraction by the addition of dioxane in which the tannin is largely soluble. The dioxane-insoluble material (5 percent of total extract) is a grey non-hygroscopic powder consisting of cyclitols, simple sugars, polysaccharides, and what appears to be a fat

[1] Presented at Session V, Chemical Utilization, FPRS 13th National Meeting, June 28–July 1959 in San Francisco.

Fig. 3.—Redwood boards, left, unexposed and, right, exposed to high humidity.

stable phenolic material. The cyclitols (30 percent of total water solubles) have been identified as sequoitol, pinitol, and meso-inositol, while the sugars (0.5 percent of total water solubles) consist of glucose, arabinose, and rhamnose (3). The remaining components are a polysaccharide (1.5 percent of total water solubles) and a non-tannin type polyphenolic compound (18.0 percent of total water solubles). It soon became apparent that these dioxane-insoluble materials were quite stable, while the dioxane-soluble fraction, containing tannin and other polyphenolic compounds, produced an extremely hygroscopic and labile product upon recovery. It is this later entity that appears to be largely responsible for the occurrence of stain in redwood.

The dioxane-soluble fraction contained up to 50 percent tannin as determined by the hide powder method (4). The portion that was not absorbed by the hide powder contained what appeared to be, among other things, a polyphenolic compound or compounds which were very labile. What little is known concerning redwood tannin was discovered in experiments carried out some years ago by Buchanan, Lewis, and Kurth (5). They found that, upon alkaline fusion, the tannin yielded protochatechuic acid and catechol among the reaction products, while the completely methylated tannin produced veratic acid. This information, together with other reactions, indicated that the product is a phlobatannin built on the catechin model. These investigators likewise found, in the tannin fraction, a material which was not absorbed by hide powder but which contained approximately the same methoxyl and total hydroxyl groups as the total fraction. The investigation of the chemical nature of this fraction as well as of other unidentified redwood extractive components is being continued.

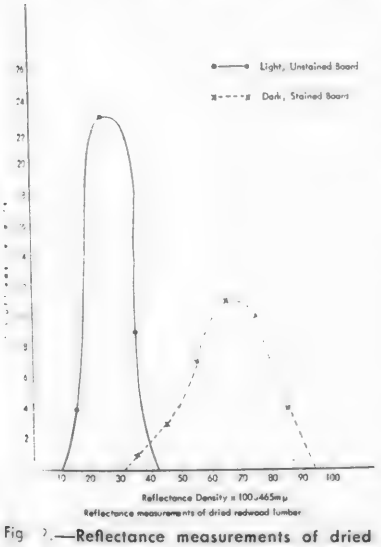

Fig. 2.—Reflectance measurements of dried redwood lumber.

Redwood Sticker Stain and Migration of Extractives During Drying

Several years ago, at the suggestion of the California Redwood Association, a preliminary investigation was made into the chemistry of redwood sticker stain (6). When redwood lumber develops sticker stain, the region bordering the sticker may be much darker than the area directly under it. It was initially decided to study the distribution of extractives in each of these areas. For this purpose, microtome sections were removed to a depth of 1/16 inch immediately under the sticker area, and extracted with hot water to determine the amount of extract removed. This procedure was repeated for the darker areas adjacent to the sticker. It was found that the darker areas contained a much larger quantity of extract (sometimes over 100 percent more) than the lighter-colored area beneath the sticker. The extractives which would normally have been deposited at the sticker position if free evaporation were possible had migrated to the zone adjacent to the sticker, thus adding to the normal concentration of the extractives in that area.

Upon investigating the distribution of extractives at various levels below the surface to the center of the board, it was found that the inner core of the dry board contained the least amount of extract. This established the mechanism of the movement of extract while green redwood lumber is being dried. As moisture moves from the center of the board to the outer surfaces, it carries some water solubles; as the moisture evaporates from the surface, it leaves a heavy deposition of water solubles at or near the surface. The greater the concentration of extract at the surface, the more intense is the stain or development of subsequent staining.

Influence of Drying Schedules on Redwood Stain

The California Redwood Association sponsored a project to study the effect of varying drying schedules of redwood sinker stock as they relate to the staining problem, i.e., which drying schedule would produce the least amount of stain. The project dealt with two phases of the problem: 1) the influence of distribution and nature of extractives on staining and 2) the behavior of isolated redwood extracts under dry kiln conditions.

Method of Analyses

Preliminary investigation indicated that most of the extractives in redwood could be completely removed by extracting first with cold water, followed by hot alcohol (71° C.). The type of extractives removed by each of these solvents during successive extractions may be summarized as follows:

Solvent (successive extractions)	Type of extractive component removed
Cold water	Tannin, other polyphenolics, cyclitols, sugars, polysaccharides
Hot alcohol	Polymerized tannin, phlobaphenes, coloring matter

The procedure used to determine the distribution of extractives was as follows: A 1-inch cross section was cut from two selected 4/4 boards prior to seasoning, and again, from the same boards, at the conclusion of the drying schedule. The sections for extractives

distribution were cut into three zones: a surface or outer zone 3/32 inch thick; an intermediate zone 3/32 inch thick; and a center zone or inner core 3/16 inch thick. The two outer sections were combined and analyzed as were the two intermediate sections and the single core section.

Each of the respective zonal area sections was extracted consecutively overnight with cold water followed by an overnight extraction with hot alcohol. The quantitative analyses were carried out as follows: Each thin section was cut into small pieces on a paper cutter. The small pieces were then ground in a large, stainless steel Waring blender, using 500 ml. of distilled water. The absence of iron was essential since this would have reacted with the tannins present in the aqueous redwood extract to discolor the solution and interfere with subsequent spectrophotometric evaluation. The ground redwood was permitted to set overnight, then was filtered and washed with water. An aliquot of the solution was evaporated to dryness, and the quantity of cold water soluble extract was determined on the basis of the oven-dry weight of the extract free sample. The visible absorbance spectrum was determined on another aliquot by means of a Beckman DK–2 recording spectrophotometer. This determination was expressed as absorbance per gram of oven-dry wood in 100 ml. of water at 475 mμ.

The water extracted sample was next treated overnight with 250 ml. of boiling ethanol, filtered, and washed with ethanol. The filtrate was evaluated as described above.

Distribution of Extractives in Seasoned Redwood (Series I)

The distribution of extractives in the first three kiln runs, together with an air-dried run, is shown in Table 1. All seasoning runs reported here were carried out on 4/4 stock.

The results clearly indicate that there is a decided increase or migration of water soluble material from the inner core to the outside of the board during the seasoning period. As the table shows, the outer layers had over twice as much water soluble extract as did the inner portion of the dried board. It will also be observed that the lower relative humidities (Runs 3 and 4) produced boards with a greater quantity of water solubles at the outer surface, while higher humidities tended to produce more alcohol solubles, i.e., there was a conversion of some of the water soluble components. Also, the visible spectra of both the water- and alcohol-soluble extracts increased in color intensity.

This first series indicated that high humidities together with increase in temperature convert more of the water solubles to insoluble tinctorial materials, thus producing a darker board. While this is apparent from careful visual observation, it was desirable to measure differences in color by making reflectance readings of the board surfaces. These readings were measured by means of a Photovolt Reflectance Density Unit, Model 53. Since a cross section of the light beam in this unit is not very large, it was decided to make 36 random readings over a grid of one-inch squares marked on the surface of the board. The reflectance readings were made at 465 mμ, and the density was recorded for each of the 36 random measurements. All measurements which came within a multiple of 10 were considered equal and were so plotted, i.e., the number of readings between 10 and 20 were given a value of 15. For convenience, the density was multiplied by 100, and the average of the 36 measurements was likewise recorded. Such measurements, for a light, unstained board having a reflectance density of 26 and a dark colored, stained board with reflectance density of 65, are shown in Fig. 2.

Reflectance measurements were made on a number of boards from each of the first three kiln runs (Table 1). Reflectance readings of the boards in Run 3 averaged 36, while the boards in Runs 1 and 2 averaged 43 and 42, respectively, again indicating that high humidities in the kiln tend to produce the darker boards.

It is well known that seasoned redwood boards which appear quite uniform and bright in color may develop stain upon subsequent exposure. It was found that this subsequent staining and/or darkening, brought about by the hygroscopic nature of the water soluble extractive, could be accelerated by exposing the boards to high humidity (see Fig. 3). For this purpose, after the reflectance measurements were made on a freshly surfaced board, it was exposed to 85° F. and 92 percent relative humidity for 48 hours after which reflectance readings were repeated at the same points that were measured before exposure.

After the boards in Run 3 were exposed to high humidity for 48 hours, the average color changed from 36 to 43—an 18 percent increase in reflectance density. On the other hand, boards from Run 1 changed from 43 to 48—an 11 percent increase, and those from Run 2 from 42 to 45—a 6 percent increase. This would indicate that dried redwood lumber with the greater quantity of water solubles at or near the surface (Run 3), is more prone to greater increase in color changes than are boards with lower quantities of water solubles in the surface area (Runs 1 and 2).

It will also be noted from Table 1 that air-dried redwood, i.e., redwood

Table 1. DISTRIBUTION OF EXTRACTIVES IN 4/4 KILN-DRIED AND AIR-DRIED REDWOOD (Series 1)*

	Outer layer		Intermediate layer		Inner core	
	Green lumber	Kiln dried	Green lumber	Kiln dried	Green lumber	Kiln dried
Run #1 (130°F. 4°WBD (90% RH) 21 days, Av. MC - 187%)						
Cold water ext., %	11.47	14.53	11.60	12.28	11.63	6.4
Cold water ext., abs.**	0.046	0.134	0.049	0.072	0.055	0.0
Hot alcohol ext., %	7.22	12.73	7.51	8.16	8.85	8.7
Hot alcohol ext., abs.	0.273	0.77	0.248	0.841	0.286	0.4
Total extractive, %	18.69	27.26	19.11	20.44	20.48	15.1
Run #2 (150°F. 5°WBD (86% RH) 16 days, Av. MC - 168%)						
Cold water ext., %	11.44	13.58	11.90	11.37	11.77	5.5
Cold water ext., abs.	0.051	0.070	0.049	0.034	0.071	0.0
Hot alcohol ext., %	7.70	10.42	7.94	9.11	7.23	10.0
Hot alcohol ext., abs.	------	0.507	------	0.367	------	0.3
Total extractive, %	19.14	24.00	19.84	20.48	19.00	15.6
Run #3 (110°F. 15°WBD (58% RH) 14 days, Av. MC - 148%)						
Cold water ext., %	10.52	16.23	11.70	10.09	11.56	7.2
Cold water ext., abs.	0.083	0.117	0.103	0.077	0.100	0.0
Hot alcohol ext., %	8.48	8.48	8.31	7.35	8.20	7.8
Hot alcohol ext., abs.	0.331	0.330	0.334	0.327	0.306	0.3
Total extractive, %	19.00	24.71	20.01	17.44	19.76	15.0
Run #4 Air-dried Run (78 days)						
Cold water ext., %	11.47	18.33	11.60	13.12	11.63	7.8
Cold water ext., abs.	0.046	0.123	0.049	0.087	0.055	0.0
Hot alcohol ext., %	7.20	9.01	7.55	8.46	8.91	8.0
Hot alcohol ext., abs.	0.273	0.361	0.248	0.326	0.286	0.3
Total extractive, %	18.67	27.34	19.15	21.68	20.54	15.9

* At 30% M.C. - 160°F. - 30°WBD to 8%; Conditioning 180°F - 10 WBD - 15 hours.

** abs. - absorbance

Table 2. DISTRIBUTION OF EXTRACTIVES IN 4/4 KILN-DRIED REDWOOD (Series 2)*

	Outer layer		Intermediate layer		Inner core	
	Green lumber	Kiln dried	Green lumber	Kiln dried	Green lumber	Kiln dried
Run #5 (110°F. 20°WBD (46% RH) 16 days, Av. M.C. - 230%)						
ld water ext., %	15.65	31.70	14.67	11.98	15.05	6.48
ld water ext., abs.**	0.091	0.185	0.094	0.068	0.101	0.038
: alcohol ext., %	9.90	12.06	9.87	10.52	9.58	10.80
: alcohol ext., abs.	0.390	0.556	0.419	0.521	0.414	0.497
al extractive, %	25.55	43.76	24.54	22.50	24.63	17.28
Run #6 (140°F. 5°WBD (84% RH) 15 days, Av. M.C. - 243%)						
d water ext., %	14.53	27.33	15.82	14.82	16.45	5.71
ld water ext., abs.	0.085	0.182	0.062	0.064	0.090	0.028
: alcohol ext., %	9.25	13.40	10.44	11.06	9.47	9.82
alcohol ext., abs.	0.440	0.822	------	0.594	0.421	0.521
al extractive, %	23.78	40.73	26.26	25.88	25.92	15.53
Run #7 (110°F. 4°WBD (87% RH) 26 days, Av. M. C. - 214%)						
Cold water ext., %	14.07	24.18	15.25	10.98	13.61	4.38
Cold water ext., abs.	0.069	0.156	0.075	0.051	0.066	0.024
Hot alcohol ext., %	10.61	15.27	12.92	12.93	10.75	11.76
Hot alcohol ext., abs.	0.415	0.823	0.469	0.626	0.377	0.554
Total extractive, %	24.68	39.35	28.17	23.91	24.36	16.14
Run #8 (140°F. 40°WBD (25%RH) 10 days, Av. M. C. - 222%)						
Cold water ext., %	13.12	29.95	13.07	7.66	19.63	4.11
Cold water ext., abs.	0.068	0.159	0.066	0.027	0.113	0.017
Hot alcohol ext., %	10.90	11.48	10.33	10.22	16.66	9.03
Hot alcohol ext., abs.	0.442	0.527	0.435	0.364	0.717	0.313
Total extractive, %	24.02	41.43	23.40	17.88	36.29	13.14

* At 30% M.C. - 180°F. - 30°WBD to 8%; Conditioning - 180°F. - 10°WBD - 15 hrs.

** abs. - absorbance

exposed to low temperature and low humidity conditions, produced the greater quantity of water solubles at the surface layer. It should be pointed out that, while this series of runs did not produce heavily stained boards, the observation was made that boards from a cant that was left longer in storage before processing appeared to be more likely to stain. This would suggest that time of log storage prior to seasoning may play an important role with respect to the degree of staining.

Distribution of Extractives in Seasoned Redwood (Series II)

In the next series (Series 2), two kiln runs were carried out simultaneously on freshly cut, matched boards under different conditions in order to obviate as far as possible the effects of storage as it relates to the staining problem, and to determine the effects of kiln conditions on the degree of staining. These runs are summarized in Table 2.

The stock in this series had both higher moisture and higher extractive contents than did the material used in the preceding series. This stock also stained more heavily than the lumber in the first series. The observations previously noted are also apparent here, but to a greater degree. There was over twice as much water soluble extractives in the outer layer of the dried material as compared with the corresponding region in the green lumber. Further, the outer dried layers had five times the amount of water solubles as did the inner core. Again, the higher humidities produced boards with fewer water solubles at the outer surfaces and greater quantities of the more tinctorial, hot alcohol-solubles. This again was the result of the conversion of some of the water solubles to insoluble materials. The effect of humidity is clearly shown by comparing Runs 6 and 8 in Table 2. In Run 6, in which the relative humidity was 84 percent, the increase of water solubles at the outer layer was 86 percent while the alcohol solubles increased 44 percent (see Fig. 4.) On the other hand, in Run 8, in which the relative humidity was 25 percent, the water solubles increased by 128 percent while the alcohol solubles increased 5 percent. This clearly shows the influence humidity has on the nature of extractives during the drying schedule.

Distribution of Extractives in Sticker-stained Redwood

The distribution of extractives in the outer layer of sticker-stained redwood was determined, and the results are shown in Table 3.

It will be noted that, while the water extract content of the outer layer immediately under the sticker increased only 11 percent as compared with the amount originally present, the water extract adjacent to the sticker had increased by 75 percent. As pointed out earlier, this higher extractive content in the stained area adjacent to the lighter-colored sticker area was the result of the lateral movement of the extractives directly beneath the sticker during the seasoning period. When the moisture escaped from the exposed area beyond the sticker, a heavy deposition of extractive was left at and near the surface of the board.

Migration of Tannin

It was of interest to determine the distribution of tannin in the kiln-dried material. For this purpose, the tannin contents of the cold water extracts from the various zones in Runs 7 and 8 were determined by means of the official hide powder procedure (4). The distribution of tannin is shown in Table 4.

While the total water solubles in the outer layer in Runs 7 and 8 increased 5.5- and 7.2-fold, respectively, over those present in the inner core (see Table 2), the tannin content increased 12.3- and 11.6-fold, resepctively. This clearly indicates that the tannins have a greater migratory capacity than some of the other water soluble components.

Conclusions

Figure 5 summarizes the migration and distribution of extractives in Series 1 and 2. The migration slope shown here, M_s, is defined as the ratio of water solubles in the inner core to those present in the outer layer of the dried redwood lumber. In the first series, the migration slope was 1:2,3; in the second series, it was 1:5.0. This would indicate that the degree of migration, or migration slope, is dependent in part upon the moisture content

Table 3. DISTRIBUTION OF EXTRACTIVES IN STICKER-STAINED REDWOOD (Outer layer)

	Green lumber	Under sticker	Adjacent to sticker
Cold water ext., %	13.75	15.35	24.13
Cold water ext., abs.*	0.059	0.110	0.178
Hot alcohol ext., %	9.09	9.06	11.82
Hot alcohol ext., abs.	------	0.516	0.671
Total extractive, %	22.84	24.41	35.95

Table 4. DISTRIBUTION OF TANNIN IN KILN-DRIED REDWOOD LUMBER

	Run No. 7		Run No. 8	
	% of water ext.	% in wood	% of water ext.	% in wood
Outer layer	30.7	7.4	31.2	9.3
Intermediate layer	17.8	1.9	19.5	1.5
Inner core	13.5	0.6	20.6	0.8

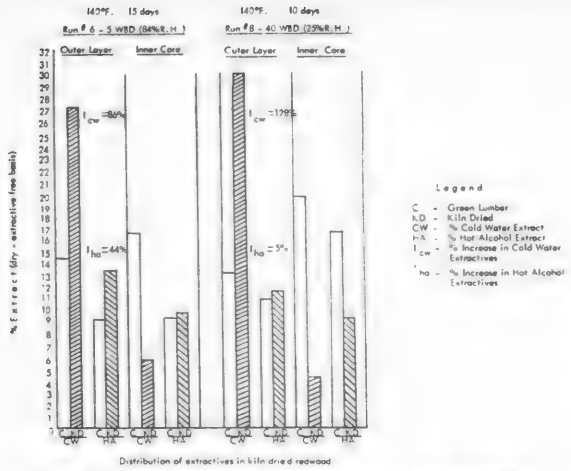
140°F. 15 days
Run # 6 - 5 WBD (84%R.H.)
140°F. 10 days
Run # 8 - 40 WBD (29%R.H.)
Outer Layer
Inner Core
Outer Layer
Inner Core
% Extract (dry - extractive free basis)
Legend
C - Green Lumber
KD - Kiln Dried
CW - % Cold Water Extract
HA - % Hot Alcohol Extract
I cw - % Increase in Cold Water Extractives
I ha - % Increase in Hot Alcohol Extractives
Distribution of extractives in kiln dried redwood

Fig. 4.—Distribution of extractives in kiln dried redwood.

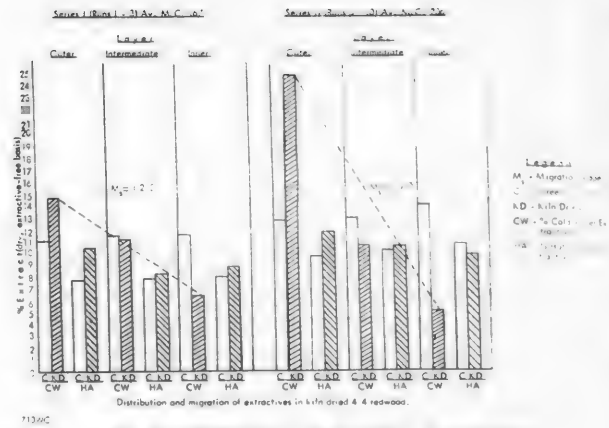
Outer
Intermediate
Inner
% Extract (dry - extractive free basis)
Distribution and migration of extractives in kiln dried 4/4 redwood.

Fig. 5.—Distribution and migration of extractives in kiln dried 4/4 redwood.

of the green material; in other words, the higher the initial moisture content, the greater the degree of migration.

To summarize the effects of kiln conditions as they relate to the redwood staining problem:

1. Irrespective of schedule used, a decided migration of extractives occurs during drying, and the degree of migration is contingent upon moisture content of the green material.
2. Higher humidities tend to increase quantities of alcohol solubles, i.e., tinctorial material, and to decrease somewhat the quantity of water solubles at the surfaces. This would tend to produce darker colored boards at the conclusion of the run.
3. Conversely, low humidities leave more water solubles and fewer alcohol solubles at the surface, and produce lighter colored boards.
4. Higher kiln temperatures tend to produce darker colored boards.
5. Although no stain may immediately be in evidence, the greater quantities of labile water solubles left in the outer zonal area of the boards are more likely to cause a greater degree of darkening and/or staining on subsequent exposure.

Effect of Presteaming on Redwood Stain

As previously indicated, conditions of high humidity and high temperature tend to convert some of the water soluble extractives, or latent stainers, into insoluble materials. This would suggest presteaming of green lumber to provide such conditions. Matched, green redwood boards were treated with saturated steam at atmospheric pressure in an autoclave for seven hours just prior to kiln drying. The matched boards so treated were analyzed for extract distribution, and the results are shown in Table 5.

The outer layer of the presteamed, kiln-dried board had 18 percent less total extract than the non-treated, kiln-dried board, a decrease of 15 percent in water solubles and of 22 percent in alcohol solubles. Similarly, there was a decrease in total extracts in the intermediate and inner core in the presteamed, dried board. This indicates that the presteaming treatment and subsequent kiln drying convert some wood extracts to both water and alcohol insolubles to reduce the degree of migration. It will also be observed that the visible spectra of both the water solubles and alcohol solubles of the presteamed boards were much lighter than was found in the untreated boards and, interestingly enough, the alcohol solubles in the presteamed board were even lighter than those from the green board.

On exposing the presteamed, kiln-dried boards to high humidity, moisture absorption was observed on the surface layers, but to a less extent than in unsteamed material (see Fig. 6). The question posed is whether, on further exposure, the presteamed material will eventually stain. It is still not clear what actually happens to the redwood extract during the presteaming period, but this, as well as other pretreatments, will be further investigated.

Behavior of Redwood Extract Under Kiln Drying Conditions

In order to get a better understanding of what happens to redwood extract during dry kiln runs, some lyophilized, cold water redwood extract was put into the dry kiln at the start of the run, and subsequently analyzed. For this purpose, about 200 mg. of the pinkish, amorphous extract were weighed into beakers and put in the dry kiln. The samples were analyzed at the conclusion of the run. Samples were analyzed for total water solubles and water insolubles, i.e., hot alcohol-solubles. Any insolubles formed would result from the condition existing in the kiln, since the extract was initially completely soluble in cold water. In each case, the visible absorbance spectrum was determined for both the water and alcohol solubles. The absorbance was calculated as follows:

$$A = \frac{\text{absorbance at } 475\ m\mu \times \text{vol. of solution}}{\text{weight of sample} \times 100}$$

The results are summarized in Table 6.

The results show that in Run 2, which used temperatures of 150°F. and relative humidity of 90 percent, almost 20 percent of the extract was converted to insolubles, and each of

Table 5. DISTRIBUTION OF EXTRACTIVES IN PRESTEAMED (7 hr.), KILN-DRIED REDWOOD

Run No. 10 (110°F. - 10°WBD)*

	Outer layer			Intermediate layer			Inner core		
	Green lumber	Kiln dried	Pre-steamed	Green lumber	Kiln dried	Pre-steamed	Green lumber	Kiln dried	Pre-steamed
Cold water ext., %	9.51	17.86	15.15	11.06	9.87	8.20	11.01	4.90	4.98
Cold water ext., abs.**	0.020	0.057	0.023	0.025	0.029	0.016	0.023	0.013	0.012
Hot alcohol ext., %	7.97	10.94	8.46	9.72	10.58	8.47	10.01	9.98	7.73
Hot alcohol ext., abs.	0.364	0.365	0.186	0.431	0.376	0.187	0.435	0.324	0.194
Total extractive, %	17.48	28.80	23.61	20.78	20.45	16.67	21.02	14.88	12.71

* At 30% M.C. - 180°F. - 50°WBD

** abs. - absorbance

Table 6. LYOPHILIZED, AQUEOUS REDWOOD EXTRACT IN DRY KILN

Run no.	Kiln condition*	Time (days)	Water soluble		Alcohol soluble	
			Per cent	Absorbance	Per cent	Absorbance
2	150°F., 90% RH	16	80.9	6.56	13.2	1.02
3(a)	110°F., 58% RH	14	91.2	3.02	8.7	0.03
3(b)	Conditioning period	15 hrs.	88.8	3.13	10.4	0.49
4(a)	150°F., 58% RH	12	78.7	1.27	21.3	0.43
4(b)	150°F., 58% RH	12	96.1	0.01	3.9	0.07

* In all runs, when M.C. reached 30%, a temperature of 160°F. and 30°WBD were used, followed by a conditioning period of 180°F., 10°WBD (79% RH) for 15 hours.

4(a) Tannin-polyphenols only; 4(b) Non-tannin

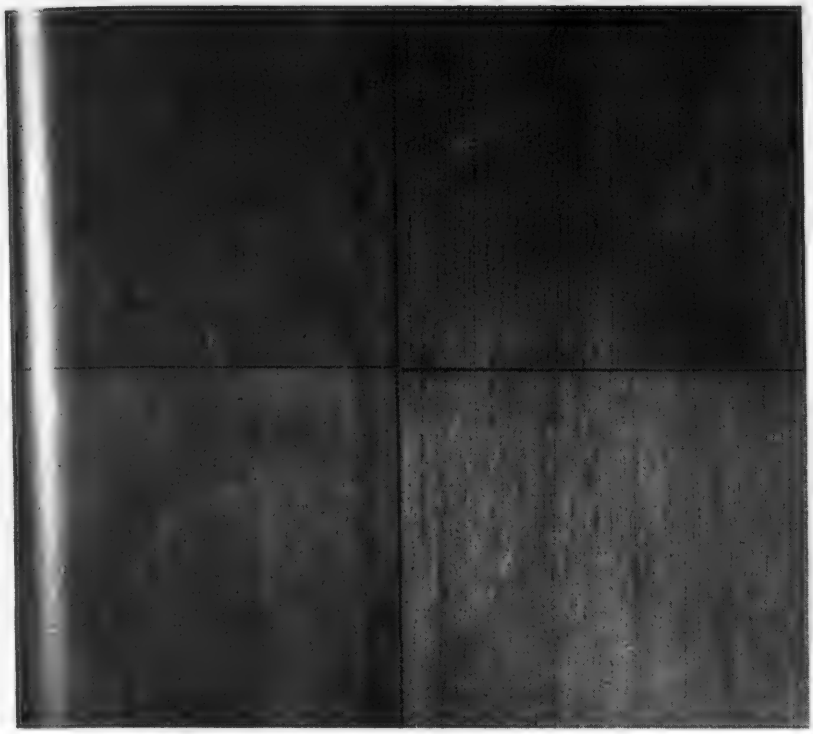

Fig. 6.—Effect of presteaming on stain. Left, presteamed boards; Right, unsteamed boards. Top, exposed to high humidity; Bottom, unexposed.

the solutions was highly tinctorial (Fig. 7). It is of interest here that, during this period, 5.8 percent of the extract was no longer soluble in hot alcohol. On the other hand, in Run 3, which employed a temperature of 110° F. and humidity of 58 percent just prior to the conditioning period, the extract (3A) did not pick up moisture, and remained amorphous. The visible spectrum of each solution was much lighter than in the previous run. A second sample (3B) was put into the kiln to determine what would happen to the extract during the relatively short conditioning period in Run 3 in which a temperature of 180° F. and a 10° WBD (79 per cent relative humidity) for 15 hours were used. Upon removal, the samples had picked up moisture and appeared as a brown syrup. As the results indicate, the amount of insolubles had increased to around 10 percent, and the alcohol soluble was considerably darker than sample 3A which was not exposed to the conditioning period. This would suggest that the relatively short conditioning period of high temperature and high humidity played an important role in insolubilizing some of the labile water solubles.

As previously indicated, the total water soluble extract can be separated into a tannin-rich fraction and non-tannin fraction by using dioxane as a preferential solvent for tannin. Each of these fractions was put into kiln Run 4 and analyzed at the conclusion of the run as before. It is immediately apparent that the dioxane insoluble (non-tannin (4B)) did not change very much during the run, while the tannin-polyphenolic fraction (4A) changed considerably since 21 percent became water insoluble. However, it will also be noted that the color of the water soluble here was much lighter than the corresponding aqueous solubles in the previous runs, and that the alcohol solubles formed here were not nearly so dark as those found in Run 2. This suggests synergism, i.e., a mixture of extractives is much more susceptible to color change than are its individual components.

The tannin-phenol fraction was acetylated, and the resulting light yellow extract was exposed to kiln conditions. Upon removal at the conclusion of the run, very little, if any, color change had occurred. Thus by changing the hydroxyl groups to acetyl groups, the tannin-phenolic components become much more stable.

Behavior of Water-insoluble Extracts in Dry Kiln

Redwood sawdust was thoroughly extracted with water, and the resulting water-extracted sawdust was extracted consecutively with acetone followed by alcohol. The solvent was distilled from each of these extracts, leaving very dark red-brown, brittle, non-hygroscopic residues which were subsequently powdered. Weighted amounts of each of these were put into kiln Run 5 (130° F. and 4° WBD, i.e., 90% RH). The visible spectra of each, before and after the run are summarized as follows:

Extract	Absorbance Before	Absorbance After
Acetone soluble	3.32	2.96
Alcohol soluble	9.06	11.15

The acetone extract was lighter than the alcohol extract and, interestingly enough, the acetone extract did not darken during the kiln run. As a matter of fact, it appears to have lightened somewhat. On the other hand, the alcohol soluble did darken somewhat during the run. While this suggests that certain of the water insolubles are subject to some color change during seasoning, it would appear that the water solubles are the most critical in so far as over-all color change or staining is concerned.

Effect of pH on Absorbance

It was of interest to determine the effect of pH and changes in pH, together with absorbance measurements, when redwood extract is exposed to dry kiln conditions. For this purpose, aqueous redwood extracts (0.68 percent solids) were adjusted by means of buffers to pH levels of 3.0, 5.0, and 7.0, their absorbance was noted, and they were placed in the dry kiln. The pH values and absorbance were determined at the conclusion of the run. Results were as follows:

Initial pH	Initial absorbance	Final pH	Final absorbance
3.0	0.095	3.1	1.83
5.0	0.110	5.2	2.24
7.0	0.230	6.9	4.40

The results show quite clearly that there was but little change in pH during the run. It will be observed, however, that the color of the solution increased as the pH was increased; and these colors were greatly intensified upon completion of the run.

Effect of Air, Oxygen, or Nitrogen on Absorbance

Since redwood aqueous extracts are very labile, it was of interest to ascertain what effect an atmosphere of oxygen, air, and nitrogen would have on extracts placed in a dry kiln run. A 1 percent redwood aqueous extract was placed in an Erlenmeyer flask, and the exposed area above the solution was replaced with air, oxygen, and nitrogen and then stoppered and put into a dry kiln run. Each of these solutions had an absorbance of 0.215 at 475 mμ before being placed in the dry kiln. The absorbance spectrum was determined at the conclusion of the run, with the following results:

In presence of:	Final absorbance
Nitrogen	2.55
Air	3.50
Oxygen	7.40

These results clearly indicate that oxygen plays an important role in increasing the intensity of stain in redwood. In other words, if redwood could be dried in the absence of air, the resulting lumber could be expected to be brighter and have less stain.

To obtain further information about the effect of oxygen in the air on the staining of redwood, 1 percent and 5 percent solutions of aqueous redwood extract were put into a hot water bath at 71° C., and air was bubbled through each of these solutions for 30 hours. The absorbance was determined before and after the treatment, with the following results:

Per cent solids in extract	Initial absorbance	Final absorbance
1	0.350	0.840
5	1.860	2.600

It is quite apparent here again that oxygen in the air plays an important role in converting certain components to tinctorial materials, i.e., in augmenting or contributing to the stain problem.

Conclusions

This preliminary investigation on the behavior of redwood extractives under dry kiln conditions indicated that redwood seasoning stain is largely due to a component fraction of the water soluble extractives. This staining component appears to be largely tannin plus other polyphenolic components, which are very sensitive to air oxidation, temperature, and high humidity.

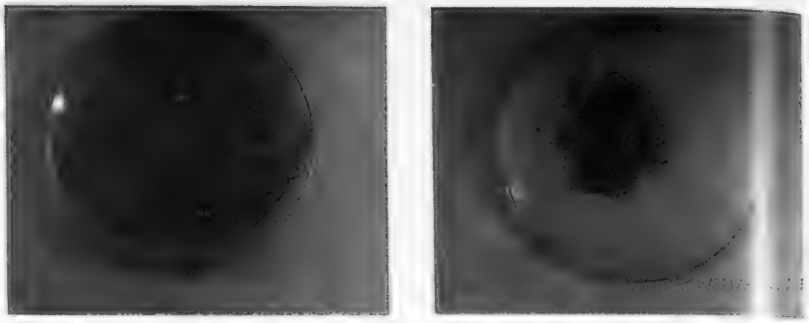

Fig. 7.—Lyophilized redwood extract before (left) and after (right) dry kiln exposure.

Acknowledgment

The authors are grateful to the California Redwood Association for sponsorship in the form of grants-in-aid, and to the Simpson Redwood Company for supplying the redwood used in this investigation. Acknowledgment is likewise made to Mrs. L. Page, Mrs. A. Wong, and Mrs. R. Smith for laboratory assistance.

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Abstracting the Literature

DECAY RESISTANCE

Rudman, P. The causes of natural durability in timber.III. Some conspicuous phenolic components in the heartwood of eucalypts and their relationship to decay resistance. Holzforschung 13, no. 4: 112-15 (Oct. 1959). [Engl.; Ger. sum.]

The outer heartwood of 13 sp. *Eucalyptus* was examd. for phenolic cpds. that might contribute to natural decay resistance. Gallic and ellagic acids were present in all 13 sp., but neither of these cpds. was toxic to the wood-rotting fungus *Coniophora cerebella* at the concens. at which they are present in *E. microcorys*. Two incompletely identified polyphenols were isolated from the methanol ext. of 9 eucalypts and examd. for chromat. behavior, soly., and color reactions. When mixed with sawdust, both of them showed slight fungitoxicity, but insufficient to account completely or largely for the decay resistance of eucalypt heartwood. 14 ref. [A.B.I.P.C. 30:6]

FIBREBOARD

Smith, Kenneth N. (Johns-Manville Corp.) Self-heating of wood fiber. Tappi 42, no. 10: 869–72 (Oct., 1959).

Fiberboards made from ten sp. of hardwood and softwoods were tested for benzene-alc. extractable content and for rate of self-heating. Self heating is defined as the increase in temp. of matl. above the temp. of its surroundings owing to an exothermal reaction occurring within the matl. The self-heating rate was detd. by heating a cubical sample of fiberboard to 325°F. in a specially constructed furnace. As the temp. of the fiberboard increased because of self-heating, the temp. in the furnace was maintained 0.5° below that of the fiberboard to contain most of the generated heat within the sample. The extractable content of the wood fiber was detd. according to TAPPI Std. T. 6 m-54, with a few minor changes. The results disclosed that the alc.-benzene extractable portion of the wood was apparently responsible for the exothermic reaction, and the rate of reaction increased linearly with the amt. of extractable matl. Two correlations were found, one for hardwoods and northern softwoods, and one for southern softwoods. 8 ref. [A.B.I.P.C. 30:6]

FOREST SURVEY

U. S. Department of Agriculture. Mississippi forests. [Forest Survey Release 81] New Orleans, La., U.S. Forest Serv., Southern Forest Expt. Sta., 1958, 52 p.

This rept. presents the principal findings of the 3d Forest Survey of Mississippi, incl. information of the kind, amt., and condition of forest resources, the inds. that support, and the possibilities for improving wood prodn. Comparisons are made with the forest inventory completed in 1948. Reflecting the expansion of the pulp ind., the prodn. of pulpwood reached an all-time high (2 million cords). A new multi-million-dollar pulp mill was established at Natchez, and existing mills were enlarged. The past decade was also characd. by a huge increase in the pulping of hardwoods. Small woodland holdings comprise 70% of all forests in the state. Remedial measures are suggested for the lack of effective forest management on lands suitable for growing ind. hardwoods. The accuracy of this survey is discussed and definitions of terms, as well as detailed and std. tables, are given. [A.B.I.P.C. 30:6]

BARK UTILIZATION

Bender F. (Can. Forest Prods. Lab., Ottawa). Spruce and balsam bark as a source of fibre products. Pulp Paper Mag. Can. 60, no. 9: T275–8 (Sept. 1959)

Mixts. of spruce and balsam fir bark as obtained from the drum barker of a pulp mill, can be fiberized with conventional equipment after the removal of slime matter. This matl. (contg. pectic substances and galacturonic acids) can be removed from the bark with the aid of a "Proteolyzer" screw-type lab. extruder. Pulps prepd. from trd. barks have freeness values ranging from 500 to 700 ml. C.F. Hardboards and insulation boards prepd. from these bark pulps meet specs. for certain classes of board. Particle boards prepd. from extruded and non-fiberized bark, using an inexpensive commercial binder, show some promise. After debarking, the pulpwood "bark" obtained from

pul· mill (consisting of black spruce and bal- n fir bark, and some wood) can be sep- into two fractions, one of which consist mainly of wood and bark fiber, and the oth- of the nonfibrous part of the bark. 6 r [A.B.I.P.C. 30:6]

PULPWOOD

P bble, J. S. (Anglo-Canadian Pulp and aper Mills Ltd.) Photographic measuret t of wood piles. Pulp Paper Mag. Can 60, no. 8: 78–9 (Aug., 1959).

T amt. of pulpwood in a pile is detd. by p tographing the log ends and projecting t photos on a screen marked off with dots A count of the dots that fall on the void nd on the bark area reveals through a sin e calcn. the proportion between solid woo and voids plus bark. [A.B.I.P.C. 30:6

Lauer, E. F., and Woodfin, R. O., Jr. (U.S. Forest Service Rocky Mountain Forest and Range Expt. Station). Pulpwood characteristics of Black Hills ponderosa pine. Tappi 42, no. 10: 809–12 (Oct. 1959).

Pulpwood charact. were detd. from trees cut on 39 plots located throughout the Black Hills and Bear Lodge Mountain area of South Dakota and Wyoming. These trees, marked according to the prevailing Forest Service procedure, ranged from 6.0 to 12.9 in d.b.h. and from 19 to 77 ft. high. All bolts from a plot were measured and stacked to get cord equivs. (128 cu. ft.). Bolts from 13 plots were peeled, measured, and restacked to get a direct comparison of cord equivs. for rough and peeled wood. The stacks from timber stands 51 to 100 yr. old contain, on the av., 59% wood (75.9 cu. ft.), 19% bark (24.3 cu. ft.) and 22% air space. In contrast, a cord of peeled wood contains 75% wood (96.1 cu. ft.) and 25% air space. A rough green cord from these stands weighs 4950 lb. (incl. 560 lb. of bark), and a peeled green cord weighs 5560 lb. A considerable drop in wt. of the peeled cord takes place when it is allowed to air dry. An a.d. peeled cord weighs 2620 lb. and contains about 550 lb. more wood than a rough cord. 8 ref. [A.B.I.P.C. 30:6]

PROPERTIES

Cheng, T.C., and Wei, K. Y. Explanatory notes on the anatomical features used in descriptions of softwoods. Acta Botanica Sinica 6, no. 1: 53–72 + 12 plates (March, 1957). [Chinese; Engl. sum.]

After discussing and criticizing the multiple-entry key of Phillips (1941) and the identification scheme of Yazenko–Khmelevskii (1954) for the description of softwoods, the authors present their own system for the identification of conifers, which is based on 25 major and 18 minor anatomical features. 31 ref. [A.B.I.P.C. 30:6]

Nyren, Véra, and Back, Ernst. The resin in parenchymatous cells and resin canals of conifers. III. Characteristics of parenchymatous cells and tracheidal ray cells of *Pinus silvestris* pulpwood. Norsk Skogind. 13, no. 8: 267–70, 272–8, (Aug., 1959). [Engl.; Swed. and Ger. sum.] *cf.* A.B.I.P.C. 29: 587.

Charact. and identifying features are given for the tracheidal and parenchymatous ray cells, the vert. parenchyma, and the parenchymatous epithelial and pith cells in the wood of *P. silvestris* grown at 59–63° northern latitude. A method for the identification of tracheidal and parenchymatous ray cells in tangential wood sections is described. Two main type of parenchymatous ray cells occur in *P. silvestris*: One type, constituting *ca.* 85% of the matl. investigated showed a charac. thickening the secondary cell wall outside the pit area. The other type (15% of the matl. studied) was uniformly thin-walled throughout, thus lacking charac. features and being difficult to distinguish in fiber suspension from vert. parenchyma cells. The rel. pit area in the first type of cells was estd. at 40%, and the proportion of thin primary wall without secondary thickening) in all parenchymatous ray cells was estd. at 50%. This high proportion is one of the factors responsible for the ease of deresination of pinewood pulps. Vert. parenchyma cells are also uniformly thin-walled and surround the vert. resin ducts in a charac. manner; their rel. proportion is estd. at 20% of all parenchyma cells, excl. epithelial and pith cells. Tracheidal ray cells are characd. not only by their bordered pits, but also by typical patterns of cell-wall thickening in tangential and horiz. radial walls. Their frequency to parenchymatous ray cells is *ca.* 2.8:2. 9 ref. [A.B.I.P.C. 30:6]

Schultze-Dewitz, Günter. Variation and frequency of fiber length in spruce. Holz Roh- u. Werkstoff 17, no. 8: 319–26 (Aug., 1959). [Ger.; Engl. sum.]

The lengths of 17,792 fibers taken from the northern and southern radial directions of wood disks cut from two spruce trees of different age and different crown class at various stem heights have been measured and were found to depend on all four of these factors. The fibers within a given growth period increased by 17–25%, the change being greater on the southern than on Northern portion of the stem and greater for the intermediate than the dominant crown type. Fiber lengths and length variations at a given stem height increased with age up to 70–80 yr. The intermediate tree had longer fibers in the early growth but shorter ones in the mature growth than did the dominant tree. Fiber length increased and later decreased with stem height, whereby several maxima could be observed along the stem within a given annual ring. In gen., fiber-length distribution was sym. (normal) over the whole stem of intermediate crown, but was unsym. (skew) for the dominant-crown tree. The av. fiber length of the dominant tree was 3% greater than that of the intermediate tree, but the difference was only in annual rings of equal width at breast height. 40 ref. [A.B.I.P.C. 30:6]

Wardrop, A. G., Liese, W., and Davies, G. W. The nature of the wart structure in conifer tracheids. Holzforschung 13, no. 4: 115–20 (Oct., 1959). [Engl.; Ger. sum.]

The devt. of the so-called "wart structures" (*I*) was studied in fresh and dried sections of *Actimostrobus pyromidalis* (*II*), *Callitris glouca*, and *Pinnus radiati*. The *I* is esp. well devd. in *II* and is formed in the final stages of differentiation when lignification is pract. complete. In *II*, the *I* comprise membranes lining the lumen, a no. of pouches protruding from the membrane into the luemn, and small apherical bodies 0.1–0.5 μ in diem. within the pouches. The membranes do not absorb UV light, but the spherical particles show strong absorption. The *I* appear to be quite distinct from the secondary wall. A method for isolating the *I* and freeing it from other cell-wall components is described, and photomicrographs and electron micrographs of fragments are shown. The *I* and *II* remained virtually unaffected by trusts with boiling water, alc., ether, urea, cold 72% and 98% sulfuric acid (for 2 hr.), boiling 17.5% sodium hydroxide, hot hydrogen peroxide, pyridine, butanol-hydrochloric acid, and cold sodium hypochlorite. The *I* dissolved slowly in 50% chronic acid and rapidly when trd. briefly with boiling sodium hydroxide followed by cold concd. chlorine water. They dissolved also on trmt. with boiling 1:1 mixt. of hydrogen peroxide (100 vol.) and glacial acetic acid, and gave some pos. reactions for lignin and protein. 15 ref. [A.B.I.P.C. 30:6]

CHARCOAL

Kishimoto, Sadakichi, Abe, Fusako, Yamaguchi, Akira, and Unrin-in, Genji. Studies on charcoal. X. Oxidadation of lignin charcoal. J. Japan Wood Research Soc. 5, no. 5: 166–72 (Oct., 1959). [Jap.; Engl. sum.]

Wood charcoal (*I*) consists mainly of cellulose charcoal (*II*) and lignin charcoal (*III*). To elucidate the props. of *I*, the charact. of *III* (prepd. by atm. and wet oxidn.) were studied. Sulfuric acid lignin from wood saccharification and lignin extd. from wood with dioxane and hydrochloric acid were carbonized in a Fischer-Tropsch retort at 500° C., and the *III* thus obtained was heated in a thermo-balance from 500 to 1000°. The carbon content of *III* increased proportionately to the temp. and duration of carbonization. Under the conditions used, the hydrogen content decreased, and there was no marked change in ash content, in agreement with the corresponding behavior of *I*. The surface area (detd. from nitrogen-adsorption data) decreased with increasing carbonization temp. For sulfuric acid *III*, it was 200 and 16.3 sq. m/g. at 800 and 1000°, resp. For dioxane-hydrochloric acid *III*, it amounted to 200, 83.5, and 9.9 sq. m./g. at 700, 800, and 1000°, resp. Different degrees of wet oxidn. (4–10% *vs.* 1–2%) were observed for sulfuric acid *III* and dioxane-hydrochloric acid *III* when both were trd. with phosphoric-chromic acid mixt., indicating that the two charcoal prepns. differ considerably in charact. Part of the difference may be attributed to the presence of sulfur impurities in the sulfuric acid *III*. During the initial stages of atm. oxidn., both *III* and *II* showed wt. increases due to the adsorption of oxygen. This phenomenon was not observed in *I*, except after washing with 2% hydrochloric acid. Some water-sol. substances must, therefore, ply an important part in the combusion of charcoal. The *III* is less reactive chemically than is *I* and has a structure resembling that of coal carbon. 9 ref. [A.B.I.P.C. 30:7]

WORLD-WIDE

Forest Products News

Fig. 1.—British Forest Products Laboratory at Princes Risborough.

The British are concentrating their work on home-grown timbers . . . quality criteria for Sitka spruce, native material for laminated structure, stain prevention and insect control, relationship between bark roughness and veneer figure, and pulping characteristics of native timbers are just a few of the projects receiving intensive effort.

Recent Developments at British

ESTABLISHED AT PRINCES RISBOROUGH, Buckinghamshire in 1927, the Laboratory (Fig. 1) is one of the many Stations of the Government's Department of Scientific and Industrial Research. Prior to this date, there was no centralized laboratory for timber research and work was mainly carried out at the Royal Aircraft Establishment, Farnborough; the Imperial Institute, London; and the Imperial Forestry Institute, Oxford. The overall program of the Laboratory covers all the main fields of timber research. Of necessity, the program must be flexible if it is to reflect new developments and trends in timber utilization and changing national requirements. From time to time, therefore, within the broad framework of the program, changes must be made to meet these various needs.

Research on British-Grown Timbers

Work on home-grown timbers has been carried out since the Laboratory's inception, but much of the early work was of an ad hoc nature and limited in scope. Although much useful information was collected, more detailed and extensive studies were required in order to assist the Forestry Commission in its choice of species for afforestation and reafforestation programs, and to suggest suitable uses for the timber from exotic species which will become available in increasing quantities from their plantations. With these aims in mind there has been since 1958, a progressive increase in research for the Forestry Commission.

A major investigation involves the assessment of the quality of sawmill size Sitka spruce timber from trees grown on various sites throughout Britain. Complementary studies are being made of the variation of certain properties within individual Sitka spruce trees. In addition to assessing the overall quality of the timber, the work is intended to give a clearer picture of the variation in quality within the tree, between trees and between trees grown on different sites.

Other projects designed to solve special problems include work on the strength properties of softwood pitprops and the strength of English ash, especially material used in the manufacture of sports goods.

Architects and engineers are showing greater interest in timber engineering, and the manufacture of laminated timber structures is a promising line for the utilization of some British timbers and it may prove to be a useful outlet for some of the advanced thinnings. Work aimed at developing working stresses for different species and grades is in progress and some laminated arches have been designed and fabricated in Sitka spruce (Fig. 2).

The Forestry Commission has selected on external characteristics, such as shape, branching, and vigor, a large number of trees for breeding purposes. These trees of potential seed source cannot be felled, but it is desirable to obtain some estimate of their timber quality. To this end, the Laboratory is considering the assessment of timber quality from samples obtained by increment borers.

As the British climate is temperate, characteristically with a high relative humidity and no prolonged cold period, there is a great risk of fungal staining in susceptible softwood logs awaiting sale or conversion. Scots pine is one of the timbers particularly prone to fungal stain. A survey is being made of the incidence of stain in timber in some of the major Scots pine growing regions. Methods of reducing or preventing fungal stain and the species of fungi responsible are also being studied.

Severe damage by the ambrosia beetle *Trypodendron lineatum* and the Lymexylid bettle *Hylecoetus dermestoides* has been reported in logs being extracted from coniferous forests in the west of Scotland. The biology and habits of the beetles concerned and methods of control are being investigated.

In Britain, it is usual to air dry timber before treating with a preservative. Progress has been made in Australia and New Zealand with a process for treating green timber by diffusion using a water-borne preservative. The process is particularly suitable for treating non-durable timber which is not likely to be exposed to the weather.

[1] Publication approved by the Department of Scientific and Industrial Research.

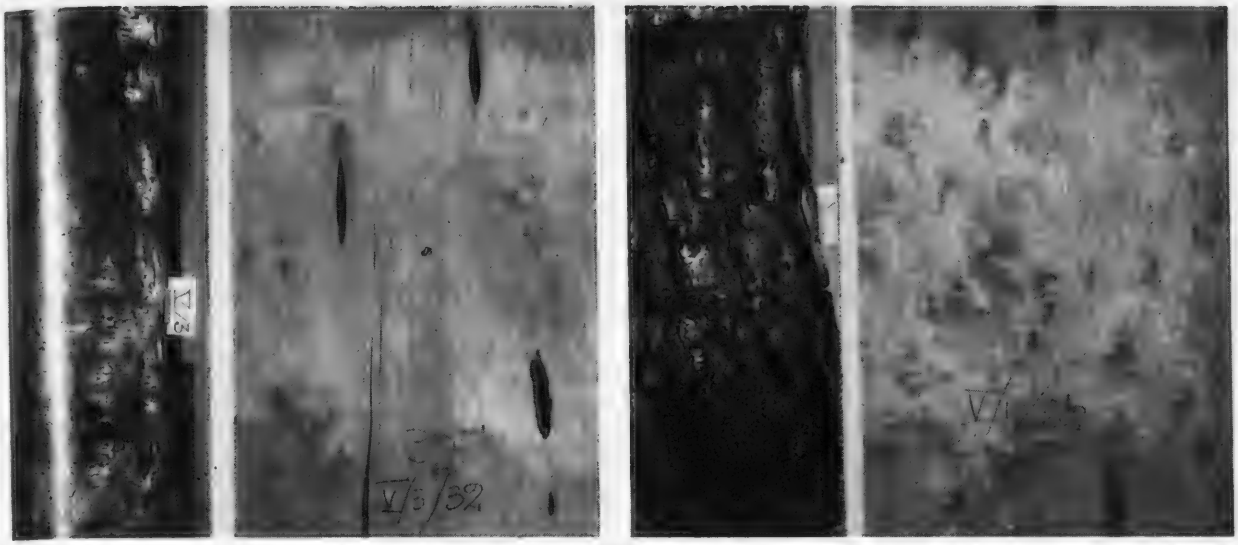

Fig. 3.—Relationship between bark form and veneer with height above ground. Note the smoother barked bilet from higher up the tree (left) is associated with straighter grained veneer.

Forest Products Research Laboratory[1]

such as joists and rafters in buildings. The Laboratory is studying the possible application of the process for treating British softwoods.

The effect of moisture content on the properties of timber has long been appreciated. With the increased possibility of utilizing softwood thinnings for pulping, the determination of moisture content has recently assumed importance in calculations for estimating the amount of dry fiber that may be expected from given volumes of wood.

The Laboratory is currently undertaking an extensive survey of the moisture content and specific gravity of various species, and supplementary studies are being made of the seasonal changes in moisture content.

Air drying of sawn timber is widely practiced, and the Laboratory is studying the behavior of Sitka spruce piled for air drying on sites in the east and west of Scotland. A device for continuously recording changes in weight has been incorporated in the stacks.

In Scandinavia and elsewhere in Europe, the characteristcs of the bark of birch trees have been used to assess the timber beneath. Limited observations on British birches have shown that there are both smooth- and rough-barked trees. Wood from certain rough-barked trees of this species may have a decorative appearance called flamy figure. Work has been initiated to study the relationship between the external appearance of the bark and the types of figure in the timber. Veneers are obtained by peeling and slicing samples from different birch trees (Fig. 3).

In recent years in Britain there has been an expansion in the production of chipboard, fiberboard and pulp from timber and timber residues. Preparations were made in 1959 for the Laboratory to carry out research on the pulping and papermaking characteristics of some British timbers. This has required the acquisition of pulping equipment, the adaptation of buildings, and the recruitment and training of suitable staff.

Other Projects

For many years, effort was expended on the evaluation of the properties of consignments of tropical and other imported timbers. Some of this work was carried out following the Second World War during a period when many timbers whose properties were not well known were reaching the British market. Over the past two years, there has been a significant decrease in this work. However, the diverse interests of the Laboratory are reflected in the many other small and large projects always in hand—some short term, other long term. They may be fundamental studies to elucidate basic scientific principles or the application of these principles to solve problems of a more practical nature.

For example, these include fundamental studies on wood-water relationships, permeability and specific heat; investigations on the nature of hemicelluloses and timber extractives; work towards developing a unified theory of woodcutting; the physiology of wood-rotting fungi; the biology of wood-boring insects; long term studies on the natural durability of timber and the durability of plywood and assembly glues; creep and plastic flow of timber under constant load; preparation of keys for the identification of wood and studies in comparative anatomy; the production of hardboard from tropical timbers etc.

The following are some of the more recent projects which are being studied. Density is a useful guide to the quality of timber and many investigations at the Laboratory involve the determination of this property. The present method is time consuming, especially with small samples such as those obtained from increment cores. In cooperation with the Atomic Energy Research Establishment, Harwell, a beta ray method of determining density variations along a strip of wood has been developed. Essentially the method depends on the absorption by the wood of a collimated beam of beta particles emitted from a radioactive source.

Only about 8 percent of Britain's land area is forest, and the timber production is not sufficient to meet the demand. Large quantities of timber have to be imported. Many of the imported timbers are used for structural purposes, and extensive studies have been made of their strength properties. For example, working stresses have been developed for Baltic redwood

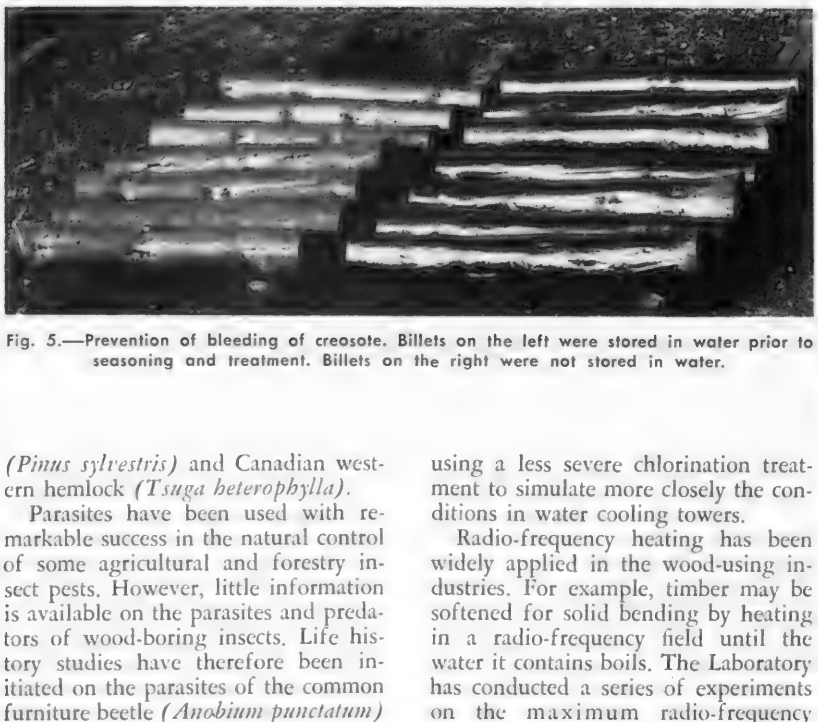

Fig. 5.—Prevention of bleeding of creosote. Billets on the left were stored in water prior to seasoning and treatment. Billets on the right were not stored in water.

(Pinus sylvestris) and Canadian western hemlock *(Tsuga heterophylla)*.

Parasites have been used with remarkable success in the natural control of some agricultural and forestry insect pests. However, little information is available on the parasites and predators of wood-boring insects. Life history studies have therefore been initiated on the parasites of the common furniture beetle *(Anobium punctatum)* (Fig. 4). The common furniture beetle is a widely distributed wood borer in the British Isles. It may cause severe damage not only to furniture but also in structural timbers, joinery, some kinds of plywood, wicker work, and timber out-of-doors including the dead parts of trees.

Although types of preservatives and methods of application have been widely studied, little is known about the behaviour of preservatives in wood during service. One reason is the lack of suitable material with a well documented history. An investigation has recently been completed on two round *Pinus sylvestris* posts treated with creosote at the Laboratory 30 years ago and whose history and treatment are known. In both posts, it was found that the loss of creosote was greater in the post above ground than below ground. Evaporation did not solely account for the loss, but it was partly caused by downward flow of the creosote.

There is a tendency for creosote to bleed from freshly treated pine posts when exposed to the sun (Fig. 5), which may prove troublesome in their utilization. Work in progress shows that water storage prior to treatment reduces the tendency to bleed and increases the permeability of the wood.

It has been increasingly apparent that soft rot is of economic importance in causing deterioration of the filling timbers in water cooling towers in industrial plants. Laboratory experiments have indicated that severe chlorination of timber accelerates the subsequent growth of the soft rot *Chaetomium globosum*. Work is now in progress using a less severe chlorination treatment to simulate more closely the conditions in water cooling towers.

Radio-frequency heating has been widely applied in the wood-using industries. For example, timber may be softened for solid bending by heating in a radio-frequency field until the water it contains boils. The Laboratory has conducted a series of experiments on the maximum radio-frequency power concentrations that some well-known bending timbers can tolerate without degrade, and to determine the approximate heating periods required to cause the water to boil freely.

The curing of glue by radio-frequency heating has been part of the research program for a number of years. Current work is concerned with the influence of the frequency on the setting rate of the glue and the quality of the resultant joint.

Publications and Reference Collections

For research to flourish there must be a full interchange of ideas. The Laboratory cooperates with timber technologists and allied workers in many parts of the world. The results of its research are published in bulletins, leaflets, special reports, records, miscellaneous publications, and articles in scientific and technical journals. A summary of the current work is published in the Director's Annual Report.

In addition, the Laboratory maintains reference collections of timbers, both samples and microscope slides, of wood boring insects and wood rotting fungi, and of timber publications issued elsewhere.

To sum up, the main trend in the recent work of the Forest Products Research Laboratory has been a large increase in research on British grown timbers and the initiation of pulping studies. This has been possible because there has been a parallel decrease both in advisory work and in the evaluation of the properties of consignments of tropical and other imported timbers.

Fig. 2.—Laminated arches fabricated from advanced thinnings of Sitka spru

Fig. 4. Larvae of the parasite *Th* *colax formiciformis* attacking the larva of a *mon* furniture beetle.

USA Allocates $4 Million To Turkish Forest Service

The Export–Import Bank of Washington, U.S.A., has allocated $4 million credit to assist the Turkish Forest Service to increase production of logs and other types of industrial wood under a five-year development program. This expansion is to take place chiefly in the six national forests of Bolu, Istanbul, Kastamonu, Trebzon, Belihesir and Nersin, where the largest areas of usable timber are located. It is expected that as the yield of Turkish high forests is expanded, increasingly large savings of foreign exchange may be realized by Turkey through a progressive reduction of imports of lumber and wood products and their ultimate replacement by sizeable, exchange-earning exports.

The credit will finance the services of a number of United States technical advisors as well as purchase of United States equipment to carry out programs in forest management, building of forest access roads, logging and sawmilling, reforestation, fire protection, and research.

An FAO technical assistance team has been working in all these fields for several years, and the country study for Turkey produced as part of FAO's Mediterranean Development Project envisages an integrated program of simultaneous action for cultivated dry lands, grazing lands, forests and irrigated areas.

–Unasylva, Vol. 13, No. 4, 19

Austrian Institute for Wood Research[1] Reports on Wood Chemistry, 1957-1958

Dr. Karl Kratzl
University Professor, Wien Austria

Austrian wood chemistry groups worked with the following problems in 1957–1958:

Pulping: Sulfite pulping of tropical wood; Base-binding ability of celluloses; Alkali pulping; Behavior of carbohydrates and especially hemicelluloses and sugars, and the formation of lignin from these.

Papermaking: Introduction of new equipment in paper and mechanical pulp processing; Addition of hardwoods into paper.

Chemical Research: Stability of methoxyl groups in lignin; Tissue culture by addition of inactive precursors of lignin; Addition of C^{14} labelled precursors to spruce and quantitative conversion to know degradation products of lignin; Development of new gas chromatographic methods for the separation and determination of alkoxyl.

The following summaries describe the various projects in greater detail.

On the behavior of labelled coniferin in the lignifying plant.

In the characterization of the incorporated radioactively labelled coniferin, K. Kratzl's and F. Rettenbacher's sulfitization and alkaline hydrolysis of the ligninsulfonic acid to vanillin and acetaldehyde was used.

Infusion of 3-C^{14}-coniferin into small spruce branches followed by sulfitization and alkaline hydrolysis yielded active vanillin and largely inactive acetaldehyde. Use of 2-C^{14}-coniferin yielded inactive vanillin and active acetaldehyde. This proves that the cinnamyl alcohol side chain is oxidized in vivo to the conjugated aldehydic side chain which upon sulfitization can then undergo reversible aldol cleavage. Both cleavage products, vanillin and acetaldehyde, are derived from the same phenylpropane system (polymeric coniferyl aldehyde sulfonic acid). K. Kratzl and G. Hofbauer. Mh. Chem. *89*, 96 (1958)

On the behavior of labelled coniferin in the lignifying plant. III.

In the project, the fate of labelled coniferin was first of all quantitatively checked. The brief effect (24 hours) of infusion was compared with the long-term (several weeks) implantation.

A water solution of 3-C^{14}-coniferin was infused into 2-year-old spruce branches. The distribution of the radioactivity was measured in the wood, bark, side shoots, and extracts. Ninety percent of the introduced radioactivity was thus accounted for.

Bark and wood were separately treated according to Hibbert's ethanolysis. Pure active vanillin and vanilloylacetyl were obtained from the lignin fractions thus separated. The molecular activities of these compounds on comparison with the molar activity of the coniferin gave the degree of dilution; these allow conclusions to be made concerning the incorporation of coniferin in lignin. The results show that the infusion method more closely resembles biological conditions than does the implantation method. K. Kratzl and H. Faigle. Mh. Chem. *89*, 708 (1958)

On the quantitative separation and determination of various alkoxyl groups by means of gas-liquid chromatography.

The current problem in the structure elucidation of natural products and the following of their reactions, especially from wood, was the quantitative determination of alkyl ethers (C_1 to C_5) in the presence of one another, which has now been solved. A new gas chromatographic method for the separation and quantitative determination of the cleavable alkyl iodides formed from organic compounds by hydriodic acid is described. Using a sample size of about 10 mg., the margin of error is of the same magnitude as that in the Zeisel alkoxyl determination. K. Kratzl and K. Gruber. Mh. Chem. *89*, 618 (1958)

Elucidation of alkali lignin. III.

In this series, V. Prey is interested in the alkali rearrangement products of carbohydrates which in the technical pulping of wood may simulate or actually produce "lignin."

In the continuation of Part II (Holzforschung *9*, 76 (1955)), the transformation of sugar into aromatics was experimentally achieved.

The formation of the aromatic lignin from carbohydrates during lignification has recently been thought of as involving shikimic acid as an intermediate. On the model substance, 6-desoxyhepturonic acid, the transformation into p-hydroxybenzoic acid in vitro could be shown whereby unsaturated cyclites similar to shikimic acid appear as intermediates. Therefore, the possibility definitely exists that other aromatic hydroxy acids obtainable from isolated lignin via potash fusion arise in a similar fashion. V. Prey and O. Szabolcs. Holzforschung *12*, 175 (1958)

On the alteration of the base-binding ability of sulfite pulps by cooking and bleaching conditions.

After a critical discussion of methods of determination of acid hydrogens in pulps, the method of K. Wilson was found to be simple and rapid and therefore especially suitable for the commercial laboratory.

The acidity of a pulp is a function of the carboxyl groups of the cellulose, the phenolic group of lignin, and in sulfite pulps also of the sulfonic acid groups of the lignin. All of these functional groups are capable of binding bases. Starting from this, the base-binding ability (BB-value) of pulps was determined and the effect of cooking and bleaching conditions was especially investigated. In unbleached sulfite pulps, the acidity of the very acid sulfonic acid group plays a decisive role; also it is shown that through continued cooking these groups accumulate leading to a maximal BB value which is reached more quickly when the decomposition temperature is raised. H. Sadler and R. Marton. Holzforschung and Holzverwertung *10*, 21 (1958)

Improving the quality of various types of papers by the addition of hardwood pulp.

This work deals with the technical possibilities of adding hardwoods (birch, poplar, beech, alder, willow) in the preparation of special papers and their positive influence on the quality of the product obtained. It is of greatest interest from the standpoint of paper technology. F. Wultsch. Wochenblatt fur Papierfabrikation *86*, 1019 (1958)

Comparative investigations on the characterization of charcoals.

Although the importance of charcoal has strongly decreased, it is still used for special purposes in industry.

[1] Österreichische Gesellschaft Fur Holzforschung, Wien III, Arsenal, Objekt 212, Austria.

A comparison of the chemical and mechanical properties of commercial charcoals is carried out.

Three charcoals from various sources and of various types were investigated. The chemical data show that charcoal S1, in spite of low fixed carbon, has the same high heat value as the carbon-rich charcoal J, while on the other hand, S1 and S2 have different heat values in spite of the same content of volatiles and carbon. Charcoal J, except for its high water content, has the more favorable composition. All three charcoals belong to the group of "low-volatile charcoals" (5–16 percent volatiles) with medium ash content (1.5–3.5 percent ash). The medium size of charcoal S1 surpasses that of charcoal J only slightly. However, charcoal S2 is more granular. The dust fraction in J is considerably lower than in S1, while the medium value of S2 was probably lowered by losses during transportation and should be less favorable. From the standpoint of solidity charcoal J appreciably surpasses that of charcoal S1 and the similar S2. H. Neusser and H. Silbernagel. Holzforschung and Holzverwertung *9*, 45 (1957)

On the preparation of eucalyptus pulp by the sulfite process.

In light of the trend to utilize tropical woods, especially eucalyptus, in pulp and paper manufacture, the suitability of this wood for sulfite cooking was investigated further.

The eucalyptus wood, density 0.677 g/cm³, used for this investigation proved to be a suitable raw material for the preparation of sulfite pulp. In contrast to spruce it can be much more rapidly cooked to a determined degree of decomposition; however, the yield compared to the same Bjorkman number, is slightly smaller in eucalyptus pulp. Almost the same unbleached yields can be reached as in spruce, i.e., 49–59 percent; however, the cooking must be carried out more gently in regard to end temperature due to a higher content of easily hydrolyzable carbohydrates. The higher density of eucalyptus permits a heavier load in the cooker whereby with the same yield a higher pulp production is obtained.

The pulp can be easily bleached in one step with chlorine dioxide or sodium hypochlorite; the degrees of whiteness that are obtainable lie around 90–92 Remission degrees in bleached yields of 45–51 percent. The strengths are below those of spruce sulfite, which is partially due to the shorter fiber length of eucalyptus pulp. While the breaking length and tensile strength are still under comparison, bursting pressure and especially folding number have the usual values. By mixing with long-fibered pulps, increased strength can be predicted. The time of beating to reach a determined point is normal. The chemical analysis confirms the greater sensitivity of eucalyptus wood to cooking and bleaching, since besides the lower DP value the β-cellulose content is higher and the σ-cellulose lower than in spruce sulfite pulps although both have been cooked under the same gentle conditions. H. Sadler and O. Trana. Holzforschung and Holzverwertung *9*, 37 (1957)

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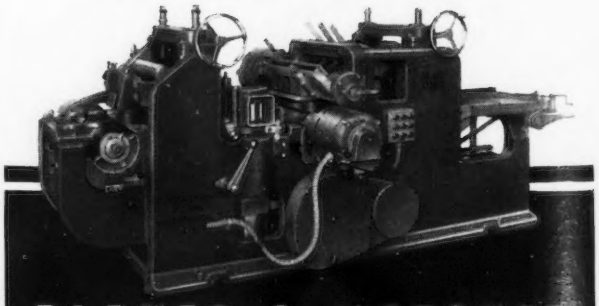

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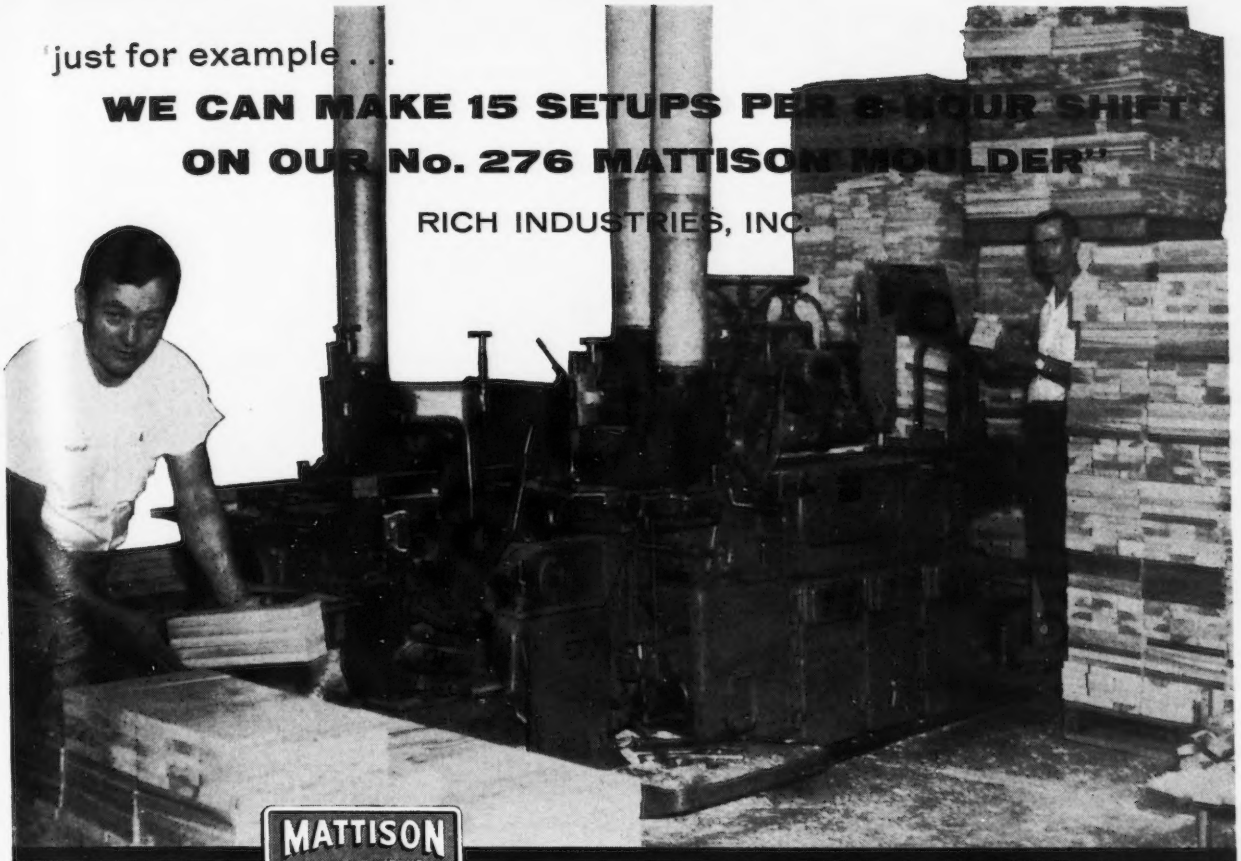

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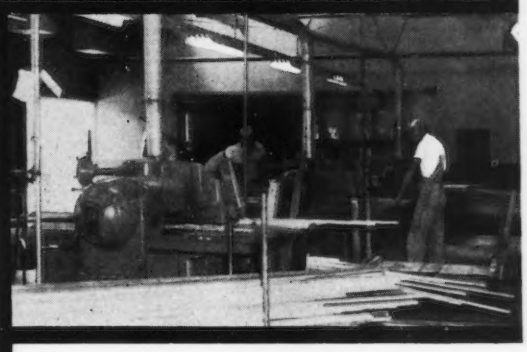

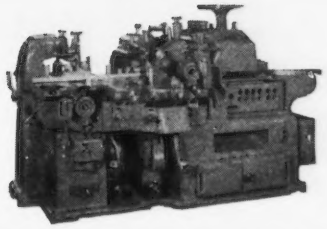

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